AGRICULTURAL ENGINEERING

MARCH • 1951

Ductile Iron — A New Metal for Farm Tool Components *H. L. Geiger and H. W. Northrup*

Field Irrigation Scheduling by the Use of Bouyoucos Blocks *Geo. Yuan Ewart*

Flood Control in the Little Sioux Watershed in Iowa *Edwin Freyburger*

A Rapid-Transfer Engine Unit for Power-Driven Farm Machines *K. L. Magee*

Minimum Requirements of Sprinkler Irrigation Equipment *(Proposed ASAE Recommendations)*

A.S.A.E. Annual Meeting • Houston, Texas, June 18-20

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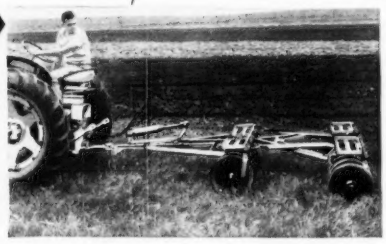
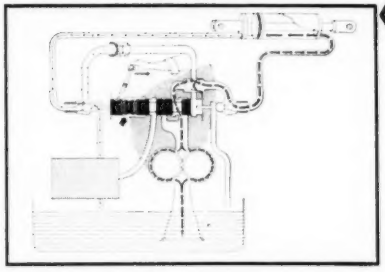
Here is a film created to bring hydraulic principles out of the realm of abstraction and make them a part of every-day living on the modern farm. Simple and clear enough for instruction at the secondary level, the treatment is technically sound — and so vivid that it fortifies understanding at higher levels, too. In fifteen fast-moving minutes it establishes a foundation of essential theory, shows construction and operation schematically, includes a wealth of applicational scenes. Arrange to see — or to show — this movie soon.

WHAT THEY DO

By action scenes with a dozen or more implements and machines, "Hydraulic Controls" teaches solid lessons in conservation farming, in saving labor, time, and other farming costs. Disk harrows are angled and de-angled on-the-go, sparing grass in waterways and on headlands. Both mounted and pull-behind implements are given attention. Function of the portable hydraulic cylinder is demonstrated, as is the interchangeability of ASAE standard cylinders.





HOW THEY WORK

Animated mechanical drawings show valves as they open and close; the pump pumps and oil flows; the hydraulic piston moves in or out at the will of the driver. Clear pictures and plain language make the workings of hydraulic controls easy to understand, hard to forget. The companion booklet of the same title can be studied at home and in class.

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Sound-slide films, 16-mm. movies in sound and color, booklets, wall charts and posters—all offered at no charge. Useful in teaching soil and water conservation and the best in modern farm methods. Send for free booklet "Case Visual Education Materials." It lists and describes each, tells how to order. A real help to instructors and club officers in planning teaching or program schedules. Address nearest branch or Racine office.

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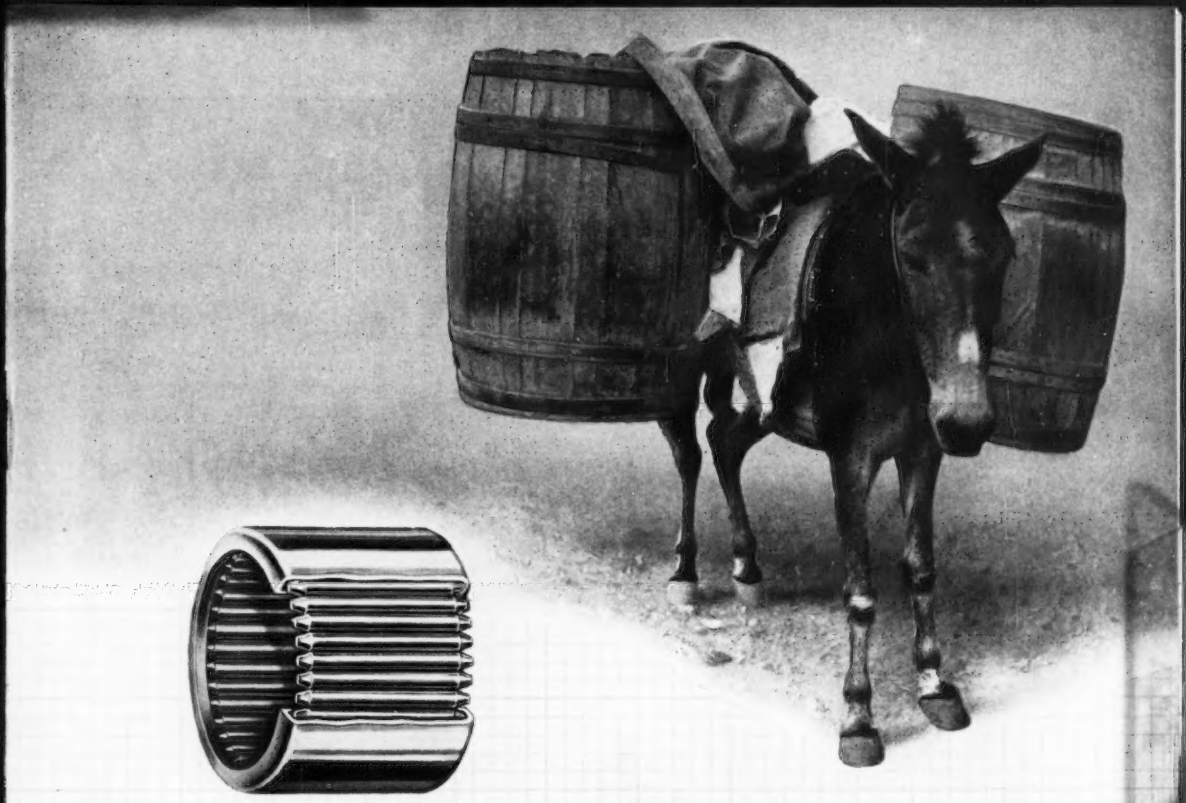
Films are loaned and booklets provided without charge to agricultural colleges and appropriate groups—extension workers, county agents, vocational agriculture teachers, student clubs. College instructors and student groups are invited to schedule this movie through their nearest Case dealer or branch, or to write to Educational Division, J. I. Case Co., Racine, Wis.



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AGRICULTURAL ENGINEERING

Established 1920

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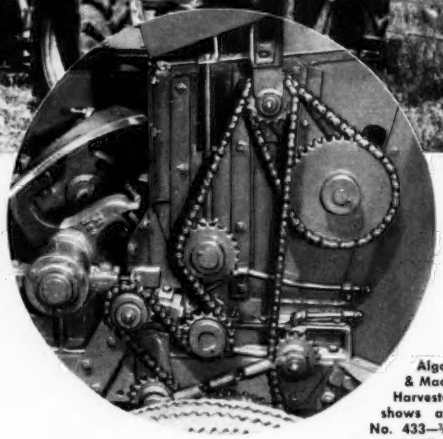

Algoma Foundry & Machine Co.'s OK Harvester. Close-up shows application of No. 433—¾" pitch Diamond Roller Chain Drives and Sprockets.

DIAMOND Roller Chain DRIVES

Diamond No. 66—½" pitch Roller Chain is used on the Innes Company Bean Windrower to drive tine reel.

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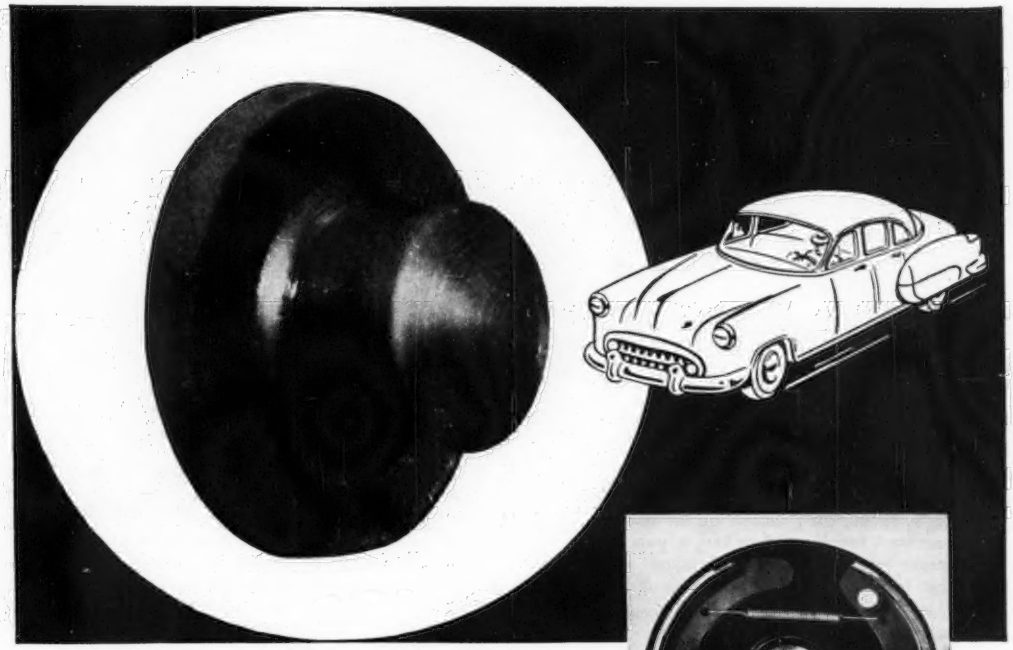
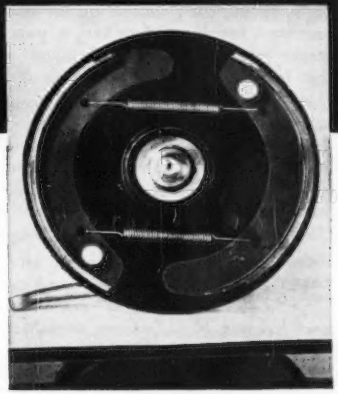
DIAMOND ROLLER CHAINS

What's U. S. Rubber doing to eliminate brake squeaks?





Located under the vertical leg of a brake shoe, this tiny button or snubber prevents metal-to-metal friction and thereby eliminates squeaks. Made of Enrup, U. S. Rubber's versatile plastic, the button wears better than metal in this application.

It is a typical example of how "U. S." experts work with original equipment manufacturers to add to the efficiency and consumer satisfaction of their products.

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THE HIGH IMPACT resistance and greater abrasion resistance make Enrup valuable on the brake shoe. The button stands up under the high temperatures generated in the brake during rapid deceleration.

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A MAN NEEDS TO BE in top shape physically to "cut the mustard" on the end of a crosscut saw for more than ten minutes. This job really takes energy! Yet thousands of cords are cut by this method on countless farms.

Other farms have power saws. Frequently they are mounted on runners so you can skid them from one spot to another. Then, you swing a sledge and pound in iron stakes to hold the saw down. You also must carry a long heavy belt and after the saw is staked down you line up the tractor and back it into the belt. This takes time.

In the woodlot you usually have wood to "buzz" at several locations. Some farmers may elect to go through the trouble of setting up at each location. Most farmers, though, understandably prefer to load their logs, heavy as they are, on a wagon or sled and haul them to the saw set up in the farm yard.

The Dearborn Cordwood Saw and the Ford Tractor are changing this picture. The Ford Tractor carries this saw anywhere. Ford Tractor Hydraulic Touch Control lowers the saw to the ground. The belt lines up and tightens automatically. No iron stakes, no sledge, no lining up and backing into the belt! No reason to lift and haul long heavy logs to the farm yard for sawing. Saw them up wherever they are and simply throw the chunks into a wagon!

Ford TRACTOR

Here is just one more example of how Ford Farming is changing farm practices. This implement is inexpensive, can pay for itself in one season of economically producing home-grown heat. It helps get rid of windfalls and undesirable trees and thereby speeds saw timber to maturity. Sawing fence posts, custom work and sawing for sale are other profitable ventures.

To get the complete story of Ford Farming, see your nearby Ford Tractor dealer.

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Dearborn FARM EQUIPMENT

Ford Farming

MEANS BETTER WORK ... MORE PRODUCTION

The silo is built on the ground, then hoisted into place on the concrete foundation. A double thickness of plywood was used for the lower half, a single thickness for the upper portion. Panels are nailed and glued to 2"x4" studs, spaced 2' apart. Bolted forming hoops are removed after the structure is completed.

"Plywood Silo Is Excellent Investment; No Sign of Leakage or Spoilage,"

Says Dairyman Phil Rawnsley, Commenting On This Silo of Exterior Plywood Construction

IN 1949, the Extension Service and the Department of Agricultural Engineering, State College of Washington, designed and cooperated in building this plywood silo on the Phil Rawnsley farm, near Kelso, Washington.

"The silo has been more than satisfactory," Mr. Rawnsley says. "Its design is calculated to carry a load of about 70 tons. We have filled it with as much as 120 tons of grass ensilage. Even then there was no sign of leakage or distortion."

The silo is constructed by gluing panels of Exterior-type Douglas fir plywood to vertical 2"x4" studs. In effect, the glued joints give a continuous band of plywood in the form of a cylinder.

Washington State College Popular Bulletin No. 198—"Building a Plywood Silo"—has this to say about the structure: "One of the features of this type of silo is that no horizontal hoops are required after construction is completed. It has been found from experience that the plywood, with properly glued joints, has sufficient strength to withstand the pressures on a silo this size. The plywood may be thought of as a metal plate and the glue as the weld. The 2"x4" studs serve a twofold purpose—(1) to transfer the weight to the foundation, and (2) to act as a splice-plate for the plywood."

BRIEF SPECIFICATIONS

Height—32 feet
Diameter—12 feet
Weight—1,900 pounds
Capacity—About 70 tons
Foundation—Concrete

Washington State College Bulletin No. 198, containing step-by-step building instructions for this silo, may be obtained from Douglas Fir Plywood Association, Tacoma 2, Wash. or Department of Agricultural Engineering, State College of Washington, Pullman, Wash. Also available from Douglas Fir Plywood Association is a booklet "Better Farm Buildings With Exterior Plywood," which contains section on silos. (Offers good in U. S. A. only).

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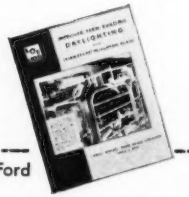

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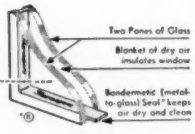

the "Green Thumb"

COMES NATURALLY NOWADAYS!

Practically every community *had* one—the man with a "green thumb."

He could make 'most any kind of plant thrive anywhere.

"Making things grow just comes naturally for John," folks agreed. Some said, "He plants in the light of the moon," while others maintained that he performed this task in the *dark* of the moon.

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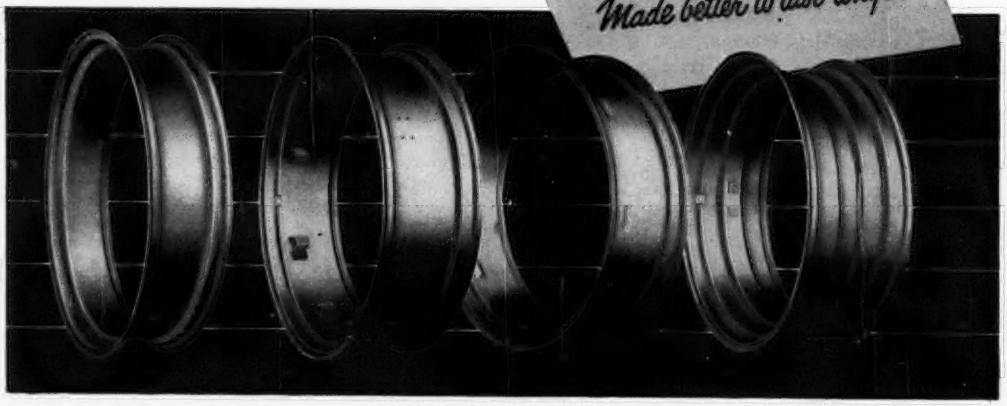

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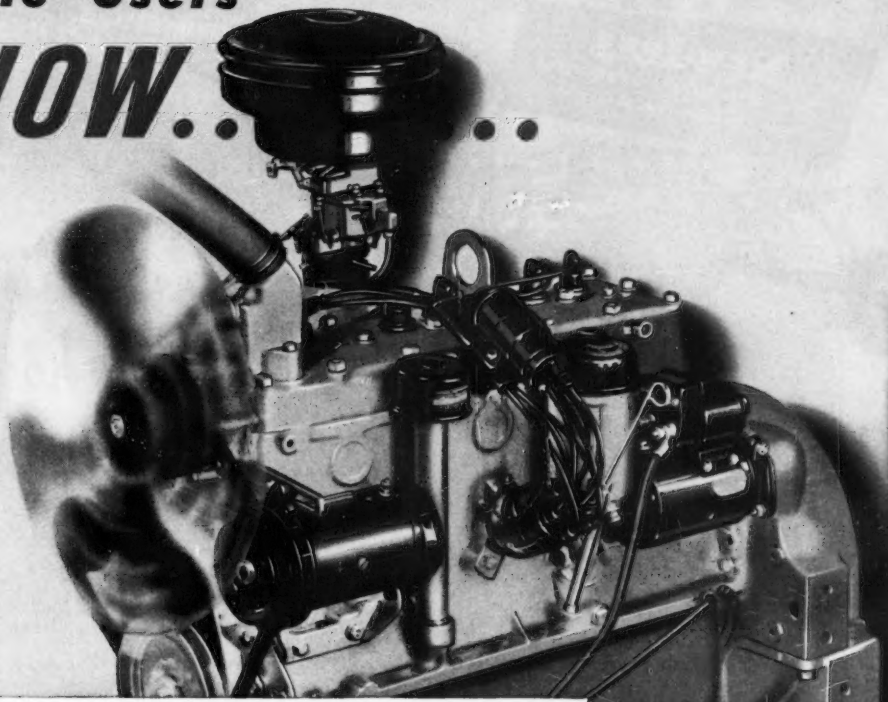

Chrysler Industrial 7—one of eight basic models.

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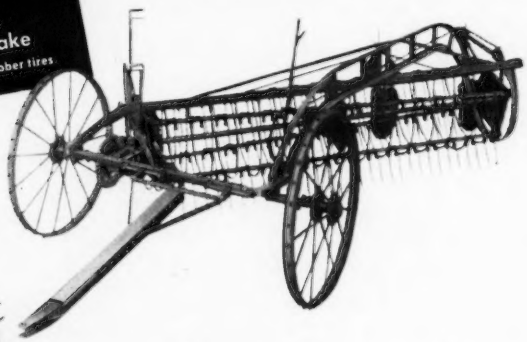
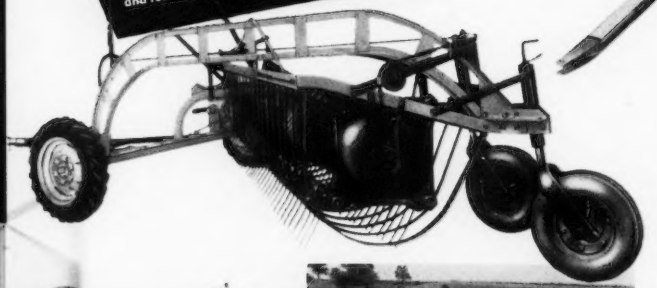
and tedder, 4 bar—steel wheels or rubber tires



NEW IDEA
No. 45-G side delivery rake
and tedder, 4 bar—rubber tires, for tractor use only



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No. 175 PORTABLE ELEVATOR—driven by any available source of power

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Remember... ...if it's a **NEW IDEA** it's a good idea

51 years of building NEW IDEA equipment ...better equipment for *Better Farming*

NEW IDEA

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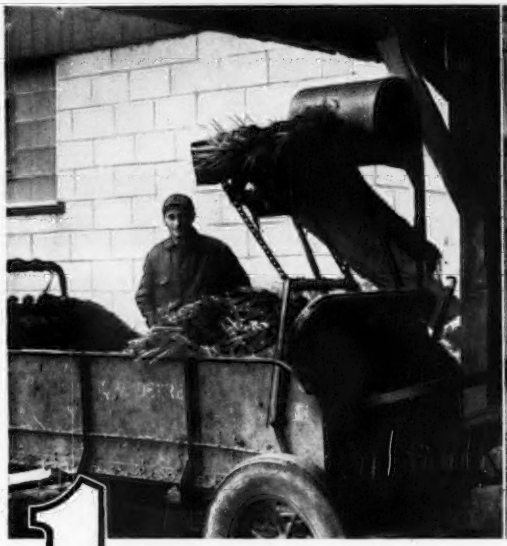
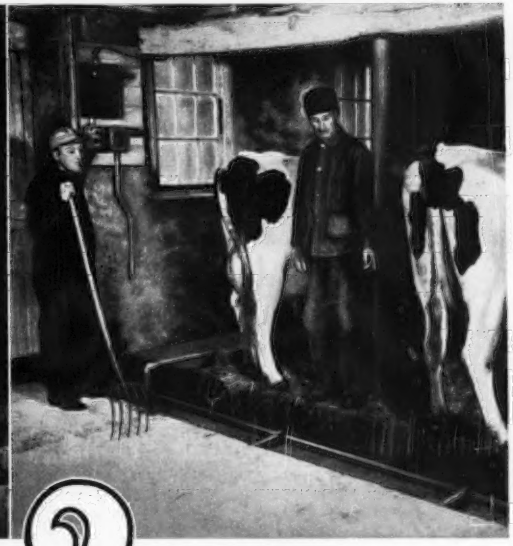
Henry Zellmer

Says Alfred Zellmer, Larsen, Wisconsin





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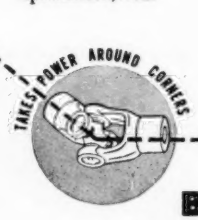

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EDITORIAL

Representation in Standards

U. S. SENATOR Ralph E. Flanders of Vermont has a long and distinguished record as an engineer advocate of engineering attention to and participation in public affairs.

Recently he has given particular attention to exposing the fallacy of standardization by governmental decree. In an article, entitled "How Big Is an Inch," in the *Atlantic Monthly* for January, 1951, he indicates that there is strong sentiment in some quarters in favor of the decree approach to standardization. It might be brought to reality as an administrative measure under emergency powers, or by laws passed without the people or their representatives being fully and correctly informed on the subject.

Public appreciation of the values of standardization is increasing. Large sections of the public use many products differing in materials, shape, dimensions and other properties only in minor degree. It becomes readily apparent to the user of any particular item that its standardization, in the form he particularly prefers, would make it more readily available to him at lower cost, with reduced difficulty of identification and reduced danger of incorrect shipment and use.

It may appear to the user that delay in standardization of this item for his benefit is due only to indifference, obtuseness, or whimsical preference on the part of the individual manufacturers for their own particular variations of the item.

It may also appear to follow that standardization by government order would provide an effective short cut to the desired result.

Engineers will recognize that viewpoint as an oversimplification of the problem of developing desirable standards. It is an oversimplification of the physical and economic considerations involved in arriving at a satisfactory standard. It is also an oversimplification of the human mechanics of arriving at a satisfactory working agreement, the spirit of standardization.

The physical and economic considerations, in most cases, involve far more than an arbitrary choice of one of several equally desirable materials, sizes, or shapes.

Standardization is in fact only one phase of engineering production. It involves numerous individual cost and use-value factors which are changeable and difficult to evaluate. It involves complex and changeable interrelationships of these factors which defy precise calculation. Like other phases of engineering production it represents the type of problem which has proven to be most effectively handled by the engineering method of progressive refinement.

To accomplish the purposes of standardization, standardized products must be able to command a consumer preference over non-standard products, in free competition on a cost and use-value basis.

Representation of interested parties in the development of a working agreement is recognized as important to their giving it whole-hearted and effective support. At first glance, the government might seem to provide ideally for automatic and complete representation of all parties interested in standardization. Further study, however, reveals its limitations as a representative of its citizens in the development of standards.

One of these limitations is that the government provides excess representation. In the case of many individual items subject to standardization the parties directly interested represent less than a majority of the whole population. The interests of this majority in other matters are bound to influence the performance of their governmental representatives on standards of primary interest to a minority.

Government representation is theoretically equal for all citizens. On the other hand, the interests of a few producers or a small group of consumers in a particular standard may be a thousand or a million times greater than the interest of comparable numbers of other citizens. A government dedicated to equal representation of the general interests of all of its citizens is inherently not adapted to representing any of them in proportion to their special interests along certain lines.

Government could not provide intelligent and well-informed representation of all the various interests in any one standard without a great deal of wasteful duplication of effort and other lost motion. In order to act effectively as an intermediary between hundreds or thousands of producers, distributors and consumers and to be sure they were all adequately represented, government agents would have to obtain from them and digest and interpret a mass of production, distribution and use data based on years of experience. The principals concerned with standardization in any field are best equipped with information and interest to handle that standardization directly for and between themselves. There is no occasion for their employing or supporting outside intermediaries.

Senator Flanders readily acknowledges the legitimate interest in standards which the government has as a major purchaser; its numerous constructive contributions to progress in standardization, and the abilities of numerous government career men interested in standards. The question which concerns him, and our whole population, is as to the proper place of government in standards work, considering the nature of the problem and the form of organization by which it may be worked on to best advantage.

One of the blessings of representative government is that loyalty to it does not require blindness to its imperfections and limitations. It does some things better than others. It is the best form of organization yet developed for the common defense and the protection of individual rights. One of the most important of these individual rights which it should protect is the right of individuals to further organize voluntarily among themselves within the law but apart from their governmental organization, in whatever ways may seem best to them for the development of their various legitimate special interests. One of the more important of those legitimate special group interests to be promoted by extragovernmental organization is the matter of standards.

Entombed Knowledge

PROTOTYPES of the modern plow, grain drill, and irrigation facilities were known to the Sumerians in Mesopotamia around 1800 B.C., according to a recent announcement by the University of Chicago.

The evidence is provided by translation of cuneiform script on a clay tablet found last year in archaeological excavations at Nippur in Iraq, one hundred miles south of modern Baghdad. It is reported to be the earliest known detailed account of agricultural techniques.

Presented as instructions from Ninurta, god of the farmers, this early agricultural extension bulletin particularly recommended planting seed two fingers deep and irrigating a fourth time to net an extra yield of one cup in every ten. Apparently it was recognized to be good economics then, even as today, to boost production per man-hour and per acre.

A stimulus to speculation is found in the fact that this is rediscovered entombed knowledge, rather than a part of the record of a continuing civilization. The clay tablet was better preserved against the ravages of time and circumstance than the population it admonished to agricultural practices for self-preservation.

Apparently Ninurta's agricultural engineers and biological scientists were on the job and had at least a part of the know-how with which to increase the productivity of agriculture. They appreciated the importance of productivity. Did their knowledge go far enough? Did they become self-satisfied and lose their intellectual curiosity? Were they discouraged by tradition and lack of support?

Did Ninurta have agricultural extension men and did they really get this information adopted in general farm practice? Was this important bulletin hauled *(Continued on page 188)*

Good Reasons—— WHY MANY ORGANIZATIONS WORK WITH CLARK

Here is another good example—one of many—to prove that it pays to work with Clark: A transmission-axle unit designed especially for a road grader by the manufacturers' engineers and Clark engineers working together.

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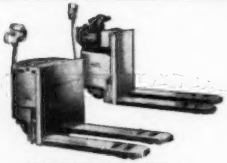

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AGRICULTURAL ENGINEERING

VOL. 32 MARCH, 1951 NO. 3

A New Metal for Farm Tool Components

By H. L. Geiger and H. W. Northrup
MEMBER A.S.A.E.

ABOUT every decade since 1850, a new metal product or process has been introduced which has opened new fields of application or has paved the way for better quality in tonnage volume. In the past hundred years this was true of the major advances in steel. In the past 50 years the cast-iron industry has made strides mainly in the matter of improving properties of cast iron through advances in melting and heat-treatment practice, and by the use of alloys and inoculants.

During this period of improvement of the various iron processes, investigators from time to time devoted part of their efforts towards finding a simple ladle addition to gray iron which would change the graphite form from flakes on solidification, to some other pattern, preferably to a round shape such as that of temper carbon in malleable irons. Such investigators felt to accomplish this would result in overcoming some of the brittleness inherent in the flake graphite structure of cast gray iron, perhaps strengthen the iron and possibly render it ductile, not to the extent of 20 per cent elongation such as that provided by annealed ferritic malleable, but perhaps to the extent of 5 to 8 per cent as-cast, which would open new fields of application for irons.

To accomplish this would amount to the creation of an entirely new product and could be considered a major stride in cast-iron metallurgy if it survived the commercial aspects.

Working independently in this country, our company found that magnesium, although insoluble in iron, when properly added to either hypo- or hyper-eutectic irons would convert the graphite flakes of these irons to a spheroidal form on solidification, impart ductility and strength, and increase the rigidity of the part in the as-cast condition.

This product was first referred to(1)* on May 7, 1948, and formally announced to the foundry industry(2) on February 17, 1949, under the name of ductile cast iron, and on October 25, 1949, patents were granted on this product (U.S. Patents Nos. 2,485,760 and 2,485,761). In order to control processing details, production has been on a licensing basis. At the present time, there are about 100 companies producing ductile iron, thirty of which are in foreign countries.

Although the basic metallurgy of the process was quite thoroughly developed prior to announcement to the foundry industry, more data has been acquired about the characteristics of this new product when applied to everyday foundry production. It can be said now that after a year of developing foundry know-how, this product is emerging as one which will be with us for some time.

The behavior of magnesium is primarily two-fold: (a) It acts as a desulphurizer, and (b) in controlled amounts it produces spheroidal carbon instead of flake graphite in gray iron. The following is the spread in analysis of currently produced ductile iron castings:

Carbon	3.30	3.90
Silicon	2.20	2.90
Manganese	0.20	0.60
Phosphorus	0.020	0.11
Sulphur	0.005	0.015
Nickel	0.50	2.00
Magnesium	0.05	0.08

It is to be noted that the sulphur range is very low for a cast iron, and is the result of the desulphurizing action of magnesium. Normally a higher sulphur is found in gray iron and is present in the form of manganese sulphide. In such irons, manganese is present in amounts ranging from 0.60 to 0.90 which is sufficient to "fix" the normal sulphur as manganese sulphide, leaving little of the manganese to function as a direct alloy. In ductile cast iron, sulphur is removed by the magnesium addition to as low as 0.005 in some cases, leaving the manganese free to act as a hardener, and since its potency in this direction is rather positive, ductile iron producers find it to advantage to hold manganese in their charge as low as possible, preferably under 0.40 per cent. Complete absence of manganese is an advantage in this product.

Success has been reported in operating a basic lined cupola to reduce sulphur in the iron charge, thereby lessening the amount of magnesium needed in the ladle addition.

Residual magnesium is usually a gauge as to whether the carbon content is in the graphitic or in the spheroidal form. Usually a residual of 0.05 in the iron is indicative of having obtained the spheroidal structure, this small amount being the sole contributor to this accomplishment.

Nickel may or may not be present. Magnesium metal itself reacts too violently when added to molten iron, consequently, in order to insure safe handling, it is added as an alloy with other metals, one of which may be nickel.

Phosphorus is preferred under 0.11 as it also functions to a degree as a hardener.

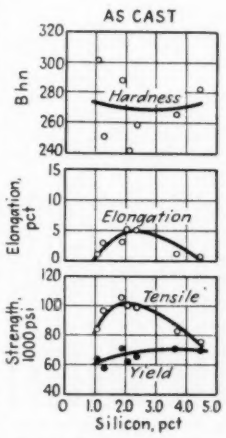

Fig. 1 Influence of silicon on mechanical properties of 1-in sections in the as-cast condition

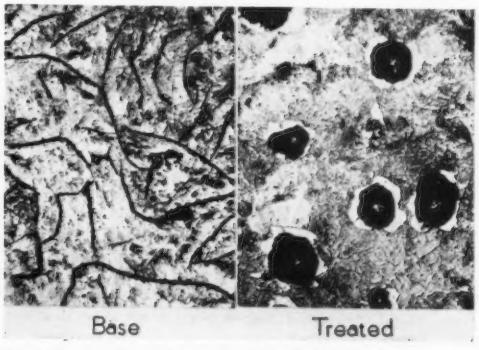

Fig. 2 Transformation of gray iron (flake graphite) to ductile cast iron (spheroidal carbon)

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1950, as a contribution of the Power and Machinery Division.

The authors: H. L. GEIGER and H. W. NORTHRUP, respectively, in charge and foundry metallurgist, Chicago Technical Section, International Nickel Co., Inc.

*Numbers in parentheses refer to the appended references.

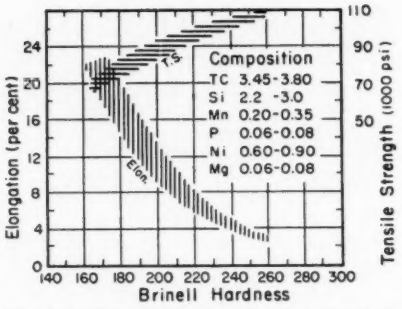

Fig. 3 Relationship between elongation, tensile strength and hardness of ductile cast iron in 1-in sections

Silicon is preferred in the limits given. In this range, maximum tensile and elongation are developed as indicated in Fig. 1.

It should be pointed out that cast irons of the above base composition in the untreated condition will develop a tensile strength of not over 30,000 psi (pounds per square inch), whereas after proper conversion to spheroidal carbon iron by the addition of magnesium will develop tensile strengths in the neighborhood of 85 to 95,000 psi, a yield point of 55 to 70,000 psi and elongations which may fall somewhere between 3 and 8 per cent as cast. Fig. 2 presents a typical gray iron before and after treatment. Fig. 3 illustrates the relationship of hardness, elongation, and tensile strength of as-cast ductile iron. Properties presented in this figure apply only to the composition range indicated. With other compositions, principally with higher manganese and phosphorus, a slightly different relationship of strength, hardness, and ductility will result.

It should be stressed that when procuring ductile cast iron, no attempt should be made to specify analysis, but rather to stipulate properties desired. A set of specifications has been proposed as follows:

MINIMUM PROPERTIES

Grade	Tensile Strength, psi	Yield Strength, psi	Elongation, per cent
90-65-02	90,000	65,000	2.0
80-60-05	80,000	60,000	5.0
60-45-15	60,000	45,000	15.0
80-60-00	80,000	60,000	No Stipulation (By agreement with Producing Foundry)

Cast specimen: One inch keel bar cast in dry sand.

Test specimen: Standard round test specimen, ASTM E-8, with 2-in gage length.

Yield strength measurement: 0.2 per cent offset or by dividers method at 0.5 per cent extension under load.

It has been generally agreed by the producers of ductile iron that these properties can be met as minimum values. Because of its newness there has been no specification set up by any of the standards organizations although it is under advisement.

Process reliability in obtaining consistent results from melt to melt is illustrated in Fig. 4 of 39 consecutive heats of ductile iron. This data was recently presented in a paper by Messrs. State and Stott (3) in which the values are for the as-cast condition. It will be noted that tensile values are consistently in the neighborhood of 100,000 psi, with yield averaging about 75,000 psi and elongation at a 4 per cent average. The analysis spread of the 39 heats was as follows: carbon, 3.57 to 3.81; silicon, 2.29 to 3.01; manganese, 0.36 to 0.51; phosphorus, 0.068 to 0.109; nickel, 0.98 to 1.45, and magnesium, 0.066 to 0.11. All heats were made in the cupola.

Pattern shrinkage has been observed to be the same for ductile cast iron as for gray iron, shrinkage for both metals being 0.15 in per ft; hence, no special patterns have to be made for ductile iron where gray-iron patterns are available. Galloway (4) made a comparison of the two metals results of which are presented in the following:

SHRINKAGE COMPARISON

Material	Gray Iron (3.20 per cent C)	Ductile Iron
Mold length, in	30 7/16	30 9/16
Casting length, in	30 1/16	30 3/16
Linear shrinkage, per cent	1.23	1.23
Shrinkage, in per ft	0.15	0.15

Measurements on the various structures have been made more recently in which the carbide free ductile iron and carbidic structure were measured as cast and after annealing with the following results:

Product	Structure	Change, in per ft
D.C.I.	Carbide free as cast	−0.15
D.C.I.	Annealed	−0.10
D.C.I.	White (carbidic)	−0.20
D.C.I.	White and annealed†	+0.10

†1650 F plus 1275 F treatment.

It should be noted that the last treatment results in a casting larger than the pattern; consequently if a small casting is intentionally cast white and subjected to the accepted annealing practice of 1650 F for 1 hr followed by 3 to 4 hr at 1275 to 1300 F, allowance should be made in the pattern if reasonably close unfinished tolerances are desired. Usually this is not considered necessary for most commercial castings.

Castings have been successfully made on a production basis in sizes ranging from a few ounces to as much as 100,000 lb. The size of castings apparently has no effect on altering the distribution and formation of the carbon spheroids. The expected drop in properties with increasing section size is indicated in Table 1 reproduced from Galloway's studies (4).

Properties, such as impact strength, rigidity, compressive strength, wear resistance, vibration damping, and others, have been investigated. Considerable interest has been shown in wear resistance and impact properties. Where maximum

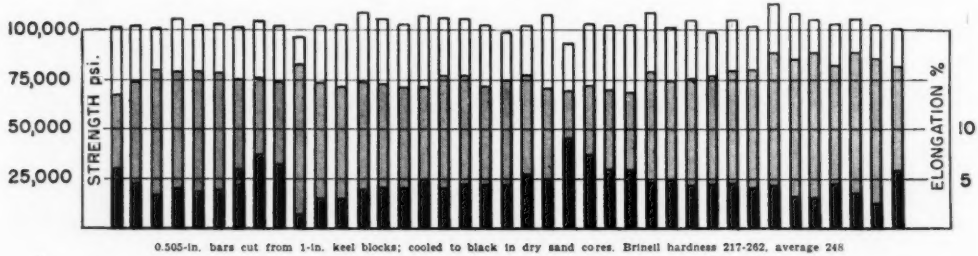

Fig. 4 Record of properties of 39 consecutive heats of ductile cast iron melted in cupola: black, elongation; shaded, yield strength; white, tensile strength

Fig. 5 Chill cast ductile iron plowshare

resistance to wear is desired, ductile iron has the property of developing a chill surface of controlled depth and hardness by casting against a metal chill. By suitable composition control a carbidic abrasion-resistant surface with a moderately ductile backing metal can be obtained. Subcritical tempering treatment toughens the chilled surface and improves the ductility of the unchilled portion. Surface hardnesses of 53 Rc to 60 Rc in the chilled area can be readily obtained with 2 to 10 per cent elongation and a tensile value in the neighborhood of 85,000 psi in the backing metal. No other cast metal known will develop this combination of properties. One manufacturer of chilled plow shares (Fig. 5) has taken advantage of this characteristic of ductile iron by applying it to his share production, and since its introduction many thousand plowshares were sold with an unconditional guarantee on breakage. The expected improvement in wear resistance over the softer white iron chill was also attained.

In such applications subjected to wear in the unchilled as-cast structure, as for example crankshaft bearing surfaces employed at 240 to 269 Bhn, it has been found that ductile iron at this hardness will provide wear resistance equivalent or slightly better than an ASTM grade 60 cast iron.

Modulus of elasticity has been determined at about 25,000,000 psi. Vibration damping properties are believed to fall midway between gray iron and cast steel based on scattered data.

Another property which would apply to farm implement and tractor parts is that of gall resistance. A gall test (5) which consists of rubbing a cylinder against an annular ring

TABLE 1. PHYSICAL PROPERTIES VS. METAL SECTION

Metal section, in	1	2	6	12	18‡	36‡
Tensile strength, psi	86,900	80,400	71,700	64,200	57,600	44,600
Yield strength, psi	61,200	63,900	57,900	56,400	48,200	43,000
Elongation, per cent	6.3	5.0	3.5	3.5	4.0	2.0
Hardness, Bhn	205	207	201	185	176	161

‡Properties from cast-on coupons.

Properties listed are averages from keel bar tests on cast Ductile Cecolloy except as noted.

Fig. 6 Ductile cast iron clevis cap cold punched and welded to steel tube

of the same material without benefit of lubrication has been developed. The cylinder is oscillated 15 deg 11 times per minute, and the load increased by 10 lb employing progressively higher loads, noting the loads that cause scoring and those that produce galling. Results of this test are presented in Table 2. A review of these values indicate comparable behavior between coarse flake graphite iron and spheroidal graphite iron and brings out the anticipated poorer showing of the fine flake cast irons. These consistent results obtained with ductile iron coupled with its resistance to deterioration at temperatures created by friction, indicates satisfactory performance for clutch plates. Friction properties are about the same as for cast iron.

Eagan and James (6) established comparative impact values for ductile iron and gray iron, employing a modified Izod impact specimen of 0.798 in. Spread of values obtained were as follows:

Normal gray iron with 30,000 psi tensile strength	10-14
Highly alloyed gray iron with 60,000 psi tensile strength	20-30
Ductile cast iron in the as-cast condition	50-90
Ductile cast iron heat treated for maximum ductility	120 plus§

§This type of material stops the tup and will not break when hit repeatedly.

These same investigators also developed comparative notched and unnotched endurance limit data for forged steel and ductile cast iron in which they found ductile iron to possess a ratio of endurance limit to tensile strength in the notched specimens of 0.26 as compared to 0.22 for the forged steel. Both metals were in the softened condition, the forged steel at 80,100 psi tensile and the ductile cast iron at 71,500 psi tensile annealed to 170 Bhn.

For applications such as gears, the designing engineer looks to compressive stress, modulus, endurance limits and tensile values, the last three of which have been discussed. Recent work (5) on compression characteristics of ductile iron indicates that the compression strength varies directly with the hardness. Yield strength under compression ranged in these tests from 57,000 psi at 219 Bhn to 95,000 psi at 321 Bhn. Ultimate compressive strength determined for the former was 125,600 psi and for the latter 178,800 psi. Per-

TABLE 2. GALL TEST DATA COMPARING DUCTILE AND GRAY CAST IRON

Type of Iron	Type of Graphite	Composition (%) C	Si	Ni	Mn	P	S	Tensile Strength (psi)	Brinell Hardness Number	Scoring Load (lb)	Galling Load (lb)	Maximum Apparent Stress (psi)
Gray	Fine Flake Dendritic	3.1	1.7	2.0	0.8	0.09	0.09	30,000	224	150	190	41,000
Gray Inoculated	Coarse Flake	3.0	1.5	2.7	0.7	0.09	0.09	36,000	218	300	400	59,000
Gray High Phos.	Coarse Flake	3.1	1.7	2.1	0.7	0.46	0.13	47,000	241	375	560	66,000
Ductile	Spheroidal	3.0	1.7	1.9	0.9	0.02	0.01	90,000	279	400	500	71,000
Ductile	Spheroidal	3.0	2.2	2.0	0.2	0.02	0.01	80,000	217	300	400	54,000
Ductile	Spheroidal	3.5	2.3	2.0	0.2	0.02	0.01	....	212	400	500	59,000

missible compressive stress for a cut forged steel spur gear hardened to 269 to 302 Bhn is about 140,000 psi. Implement producers have taken advantage of these properties where a gear material is needed to provide better properties than regular high-test gray iron.

Where added wear resistance is desired and the use of metal chillers is out of the question in such ductile iron parts as sprockets, the practice of induction or flame hardening may be resorted to on this iron. Those who have employed induction hardening report no trouble in attaining 75 shore surface hardness. Such operators report a complete freedom from cracking.

Flame hardening has found increasing favor. Table 3 presents results obtained on three heats of spheroidal graphite iron. Heating was accomplished by an Airco style 56 torch with a ¾-in flame tip. The heating tip was held at ½ in from the work moving 5.5 in per min. This developed a surface temperature of 1500 to 1650 F which produced full transformation to 0.06 in in depth with a full heat affected zone of 0.20 in in depth. Hardness values in terms of Brinell in the last two columns were converted from Rockwell A readings. Although flame hardening is not widely employed on ductile iron parts as yet, it offers many possibilities.

Ductile iron can be welded in much the same procedure as

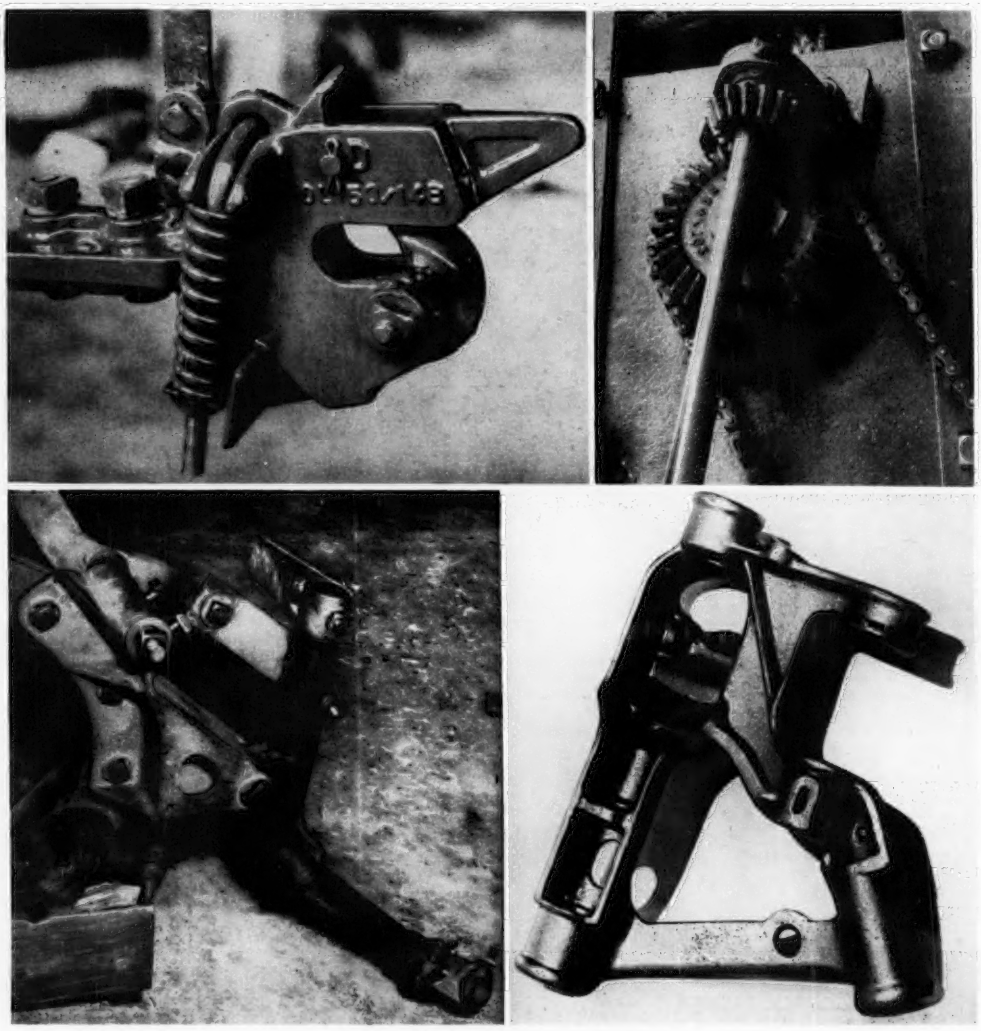

Fig. 7 These pictures illustrate the use of ductile cast iron in some farm implement and tractor castings. *(Upper left)* Plow spring release hitch. *(Upper right)* Hay baler knotter drive gears. *(Lower left)* Tail wheel mounting bracket. *(Lower right)* A tractor part. In addition to these applications, the following parts are known to be on either an experimental or production basis at the present time: hay baler ring gear, front axle support, gear carrier, implement sprockets, worm and wheel, chilled plowshares, rear axle housing, mower guards, tractor clutch plates, tractor pulleys, and tractor transmission housing

TABLE 3. FLAME HARDENING OF DUCTILE IRON

COMPOSITION						RESULTS				
							HARDNESS			
						Condition	Before hardening	After hardening	Before hardening	After hardening
							Rockwell	Rockwell	Equivalent	Equivalent
C	Si	Mn	P	Mg	Ni		A	A	Bhn	Bhn
3.66	2.25	0.16	.017	.07	1.60	As cast	52.0	81.1	160	610
						annealed	49.5	78.9	150	555
3.46	3.41	0.34	.044	.13	0.94	As cast	55.0	81.1	180	610
						annealed	54.0	78.0	176	535
3.84	2.40	0.74	.087	.14	1.00	As cast	54.5	79.5	178	570
						annealed	51.0	78.4	160	540

for gray iron. A special reverse polarity arc rod was developed for this purpose designated as Ni-rod 55 which deposits a bead with 8 per cent elongation and tensile properties of over 60,000 psi. Fig. 6 represents what one implement producer accomplished in design and weight reduction. This part employed on a loader consists of a ductile iron clevis cap to which a foot-long steel tube was welded. Bolt holes were cold punched in the cap before welding.

One of the advantages to be gained by ductile iron is the saving which may be affected in machining. This has been demonstrated in several tests; the latest to be reported is the investigation made at Metcut Laboratories and published in a condensed version recently. Table 4 presents a portion of this data.

In the as-cast state it will be noted that comparing acicular-flake graphite iron at 263 Bhn with ductile iron at 265 Bhn, there is a 25 per cent advantage for ductile iron based both on a tool life of 60 min or as measured by removal of 200 cu in of metal. Values presented are for cutting speed in feet per minute and criterion of tool life was 0.030 in land wear. All roughing cuts were taken and maintained at a feed of 0.010 in per revolution and a depth of 0.100 in. No lubricant was employed and a carbide-type cutting tool with a 6-deg true rake was used.

The last two sets of values in this table for the softer as-cast structures again shows an advantage. Metal removal in the annealed state presents perhaps a slight advantage for gray iron, but when comparing the hardness of the two materials, gray iron at 100 Bhn and ductile iron at 170 Bhn, the difference can be considered negligible. Attention is called to gray iron at 195 Bhn and ductile iron at 170 Bhn where a 3 to 1 advantage exists for ductile cast iron.

TABLE 4. COMPARATIVE MACHINABILITY OF DUCTILE AND FLAKE GRAPHITE IRON

Material as cast	Bhn	Ultimate tensile strength, psi	Elongation, per cent	Cutting speed, ft per min For tool life corresponding to 200 cu in of metal removed	For tool life of 60 min
Acicular-flake graphite	263	59700	0	150	160
Ductile Iron	265	97250	2	200	210
Gray Iron	225	45000	0	310	280
Ductile Iron	215	93000	4	310	315
Gray Iron	195	35000	0	325	320
Ductile Iron	207	84700	17.5	420	370
ANNEALED					
Ductile Iron	183	77000	20	600	500
Gray Iron	100	15700	0	960	810
Ductile Iron	170	70000	22	970	680

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Engineering Education and the Requirements of Industry

IN PARTICULAR, I shall discuss only very briefly the effect of college training on what a man is, as contrasted with the professional tools with which he is equipped. While professional training is important, of far greater importance to the success of the young engineer are his intellectual capacity, his health, and his character.

I am using the term character to designate what is probably the most important of these three components of what a man is. By this term I mean to indicate an aggregate of personal qualities which determine to a large extent a man's influence and effectiveness in working with others. They include integrity of thought, word, and act. They include both initiative and consideration for others, ability to be aggressive in carrying forward the job and at the same time to be cooperative with other people.

I believe it is true in other large organizations as it is in ours that man's progress in the organization is more frequently limited by his character than by his technical qualifications. There is the man who isn't fully adult and doesn't take responsibility, the man who antagonizes others by assumed authority. There is the timid man who does not defend his position although he is right, and there is the egotist who persists in defending his position after he has been proved wrong. There is the man who thinks of himself more than of the job and the man who tries to get the credit for work done by others. This very incomplete catalog is, I am sure, sufficient to make clear the type of consideration of which I am speaking.

To a large exter t, the most important influences on character are exercised when a man is acting as a member of a group, not merely as an individual. This means that great importance is to be placed on group activities both inside and outside the curriculum.

I was much interested recently to hear the president of a large engineering college say that the faculty have concluded that the students have too much work in the freshman year. I am disposed to agree that in spite of the tremendous pressure of need to learn more things in the course of the college years, in many cases there would be advantage in a reduction of the hours required by the curriculum. I don't mean by this that the men should be given leisure time. The purpose would be to give the men more time for extra-curricular activities which are disciplined, organized, and helpful in the development of useful traits of character. To bring this about the students probably need as much guidance and help from the faculty and other college authorities as they do in learning calculus or the theory of electrical circuits.—Harold G. Osborne in the *Journal of Engineering Education* for December, 1950.

The Mechanics of Field Irrigation Scheduling Utilizing Bouyoucos Blocks

By Geo. Yuan Ewart
MEMBER A.S.A.E.

IN HAWAII the sugar-cane industry has a capital investment of over $40,000,000 in water development. This is an expenditure by private plantations without any federal aid. According to data compiled by Wadsworth(19)*each irrigated acre in Hawaii cost over $300 in water development. Compare this with what irrigated regions on the mainland spent, i.e., $40 for each irrigated acre, and much of this was federal aid. Furthermore, not only is our development cost more than seven times higher than the mainland average, but our cost in pumping and irrigation labor is also higher; so is the value of the crop from each irrigated acre.

These are all good reasons why we should generally do more thinking on irrigation control. As sugar prices in the world market are getting more and more competitive, it is imperative that we center attention on irrigation control *now*, for irrigation accounts for from one-third to over half of the total field costs in raising a sugar-cane crop on irrigated plantations.

If we are agreed that the need for irrigation control is great, we may well ask how it can be done. Nine different ways to measure soil moisture were discussed by the author during the 1949 Hawaiian sugar technologists' meeting (5). None of them are perfect; all have advantages and disadvantages. Newer and better methods will be developed in the future. But our need is now, and mainland tests by Cummings and Chandler(4),Kelley and associates(7),and Slater and Bryant (14),plus our own comparative studies, convinced us that the use of Bouyoucos blocks, whereby soil-moisture tension is measured as a function of electric resistance, offers the most practical tool in any irrigation interval control program. However, even when the field of soil-moisture measuring devices is narrowed to the electrical-resistance type, we find such recent developments as fiberglass units and nylon units besides the plaster of paris blocks. These different dielectric materials vary in sensitivity to moisture changes as well as to salt concentration. In so far as the adverse influence of different saline concentrations of the substrate on resistance correlation with moisture is concerned, recent work by Ewart and Baver (6) indicated that units made of plaster of paris are far more insensitive to salinity effects than fiberglass ones. Increasing the concentration of irrigation water from 0 to 2,000 ppm NaCl [EC $(10)^5$ 380] and thereby bringing the concentration of 1:2 soil water extract up to 400 ppm NaCl [EC $(10)^5$ 110] resulted in little or no change in resistance of plaster of paris units for any given moisture level. On the other hand, fiberglass units were found to be significantly affected at NaCl concentrations of and above 1,000 ppm.

When the moisture content of the soil is very high, such as from saturation to field capacity, the plaster of paris blocks are poor indicators of moisture changes. On the other hand, both the nylon unit and the fiberglass unit can follow moisture changes at this range with good sensitivity. However, this saturation range is actually of little agronomic interest because it is caused by gravitational water which we cannot store in the soil or hold in reserve for the crop's needs. It is just so much drainage water working its way from horizon to horizon down the soil profile. Depending on the soil type, this "surplus" drains off the root zone in from 2 to 4 days after the irrigation application, leaving behind capillary water, which distributes itself as a film around the aggregations of soil grains and voids and is held under surface tension. This is the water we should be interested in because this is what we have stored in the root zone, and this is the net result of our gross application. As long as we have a sufficiency of this stored moisture available for the cover crop, we should not be putting on another irrigation round. To do so would not only mean throwing away water for which we have paid good money to store in the root zone in the first place, but actually water, which, enriched through its passage and storage in a fertilized soil, has become an expensive fertilizer solution with its pH constantly being adjusted by root secretion and brought nearer and nearer to a more assimilable form of inorganic solute for translocation by the vascular tissues. On the other hand, we do not want to hold off our next irrigation round until the net moisture stored from the previous round has been completely depleted, not only because a question of unequal availability of moisture may be involved but also because osmotic pressure is contributory to an increased moisture stress.

It has been established by Veihmeyer, Hendrickson and others(15,16,17,18)that capillary water stored in the soil is equally available to plants from field capacity to the permanent wilting percentage. In the past when soil moisture was universally expressed as a percentage of the soil's oven-dried weight, there have been occasions when this concept was challenged. Now, since Schofield's (13) introduction of the pF concept (logarithm of the capillary potential) and the development of precise and relatively simple techniques by

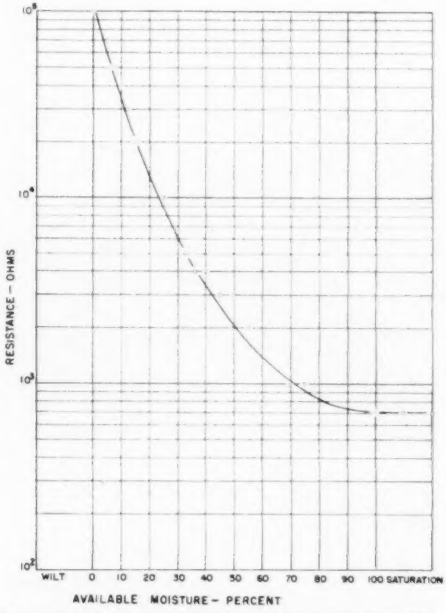

Fig. 1 Electrical resistance versus available moisture relationship for Hawaiian clay soils

This paper was presented at the annual meeting of the Hawaiian Section of the American Society of Agricultural Engineers at the University of Hawaii, Honolulu, November, 1950.

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*Numbers in parentheses refer to the appended references.

Richards and others (8, 9, 10) to measure soil moisture in terms of its pressure potential or moisture tension there are still more workers who challenge the Veihmeyer concept. Actually, when we look at some typical curves representing soil-moisture levels in per cent and corresponding moisture-tension levels, we have a very graphic picture not only of the quality of available soil moisture but also how tightly the moisture is held, hence how available it is at different points as the soil is depleted from the field capacity level (100 per cent available moisture) to its permanent wilting percentage (0 per cent available moisture). Richards and Weaver (11, 12) among others, have shown that capillary moisture at its highest or field capacity level for generally all soils is held with a tension force equivalent to 1/3 atmosphere. At the other extreme, that is, when capillary water has been reduced to the permanent wilting percentage level, the tension under which this unavailable moisture is held is equal to and above 15 atmospheres. This suggests that the total force which growing plants can bring to bear in the water absorption process (whether it is through osmosis, electro-osmosis or root metabolism) is equivalent to 15 atmospheres. Therefore, as long as moisture is held to the soil with a force below this, or as long as there is a gradient in the two opposing forces, sufficient moisture will be available to the plant to meet transpiration losses without reducing it to a state of wilt.

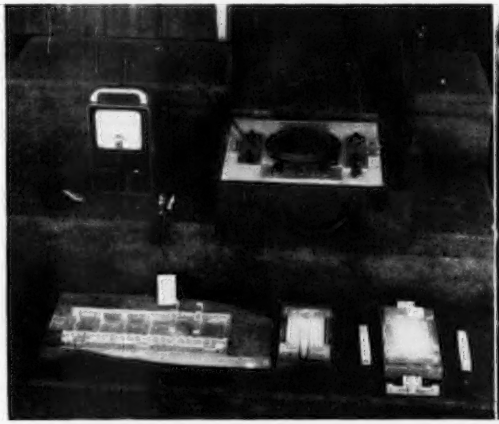
Generally, coarse soils such as the sandy loams, which have a very large proportion of their moisture available at uniformly low tensions, characterized by a sharply hyperbolic moisture-tension curve, may be said to have equal availability of moisture from field capacity to near the wilting range. For the heavier soils, such as the clay loams and clays, the moisture is most available when the gradient is steepest and becomes less and less equally available as the pressure differential is reduced. For it is logical that the steeper the gradient between the pressure potential of the soil-water holding system and that of the absorbing root system, the more rapid the rate of moisture transfer will be. This is especially true of clays whose moisture-tension curves are less hyperbolic than those of sandy soils. Although osmotic pressure can contribute significantly toward the total stress, it will not be included in this necessarily brief discussion.

The Bouyoucos blocks can measure with duplicable accuracy the rate and degree of moisture depletion from our soil reservoir for the whole range, that is, from field capacity to wilt. Blocks will generally read 700 ohms resistance when the soil is irrigated. Initial moisture losses during the three or four days following an irrigation will not be sharply reflected because the resistance changes within the block are minor as long as the soil is quite wet. Generally, after 20 per cent of the available moisture has been used up, the rise in resistance becomes greater and greater from then on as moisture content becomes less and less. The resistance rise for moisture changes from field capacity to wilt is from 700 to 100,000 ohms. Fig. 1 represents correlation between available moisture depletion and resistance rise for clay soils in Hawaii. Present work of the Hawaiian Sugar Planters Association experiment station, using equipment which we do not have at Kekaha, will give a more accurate picture with some refinement and changes in the shape of curves for different soil types.

Manufacturing Plaster of Paris Blocks. Blocks are made from pure plaster of paris prepared with sufficient distilled water to give a very plastic slushy mix. As it sets very fast, an operator should mix a batch sufficient for pouring only six molds. Approximately 400 g plaster of paris to 200 ml water (2:1) will give a six-mold batch. Molds can be made either of hardwood or lucite plastic and either in individual units or combined into a gang mold. Fig. 2 shows the two forms. The wooden molds were developed at Kekaha. The lucite gang mold was developed by Mr. Cornelison of the HSPA experiment station, as an improvement over the wooden molds which were used until then.

The leads are Okophone No. 19-2 underground telephone cable wire which is especially well insulated against dampness. The ends, stripped free of insulation and straightened with a pair of pliers, serve as electrodes. These are placed in the mold as shown and the wet mix is poured; care should be taken not to disturb the spacing between electrodes. The molds should be tapped several times to settle the mix and to prevent formation of large voids. The top should be rapidly leveled off with a spatula or putty knife soon after pouring as gypsum sets quickly and in half an hour the solid block can be removed from the mold.

The blocks are tested by being plunged into water. Large bubbles issuing from any one point on the block will indicate presence of a large void. Readings should also be made of each block for saturation calibration while the blocks are still under water. Most of them will show readings between 400 and 500 ohms at saturation. Others will be between 300 and 400 ohms with a few between 500 and 600 ohms. Blocks whose readings differ too much from the rest should be discarded as well as those which have large hidden voids indicated by bubbles. Inspection should be rigid even if the discards are as high as 10 per cent, for blocks are so cheap (averaging 15 to 20c each) that it is best to aim for uniformly similar ones. Only blocks from the same series (say 500-600



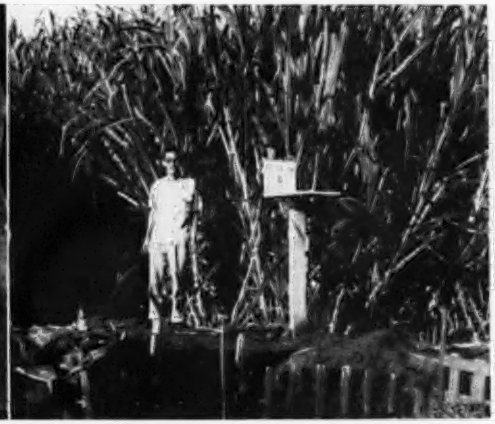


Fig. 2 Bouyoucos bridge, Bouyoucos moisture meter, plaster of Paris blocks and two forms of molds • Fig. 3 A typical station. Terminals from long leads are stapled above the numbers on the upright board. The use of long leads makes unnecessary the arduous penetration of dense cane growth for sampling

ohms series) should be used for a field or experimental installation.

Field Survey and Station Location. If fields are not very uniform in soil type or drainage characteristics, it is best to collect samples representing each 5-acre section. Either moisture equivalent data or sorption data should be obtained, depending on whether a moisture-equivalent centrifuge or a Richards pressure membrane chamber is available. If neither is available, the suction method proposed by Bouyoucos (1) requiring only a simple Buckner filter setup will give sufficiently reliable data at a small fraction of the cost of the centrifugal or pressure-chamber equipment. If a pressure chamber is used, sorption curves for the soil samples concerned, as well as resistance-tension calibration could be obtained simultaneously by using a large cylinder for the chamber so that larger samples with blocks embedded therein can be used. Calibration of blocks is not essential and need not be undertaken if they are to be used for field irrigation control. Moisture-equivalent data will indicate how uniform the field is so that, if necessary, it may be divided into two or more sections on the basis of its water-holding capacity.

Most plantations will have little to worry about on this score, but at Kekaha, where much reclamation work has been undertaken by utilizing channelled silt deposits from gully runoff, we find low humic latosol belts superimposed on dark magnesium clays which in turn merge into gray hydromorphic soils. In Kekaha, we have fields which have moisture-equivalent values ranging from 33 to 70 per cent. Values as high as 70 per cent may surprise many more familiar with sandy loams, but the dark magnesium clays and the hydromorphic clays in Hawaii are of a highly plastic consistency with over 80 per cent being less than two micron material by mechanical analysis and hence largely colloidal. In fact, generally all cultivated soils in Hawaii are clay by mechanical analysis.

Because the specially designed Wheatstone bridge used has a series of capacitor condensers (from 0.0005 to 0.05 mfd) to balance out electrostatic capacity in the blocks and in leads up to 250 ft, the field can be laid out in such a way that moisture sampling can be made in locations as far as 250 ft from a road or a supply ditch without it becoming necessary for the operator to fight his way through tall cane to reach the sampling point or block location. The greater the uniformity within a field, the lower the number of stations required; however, stations representing larger acreage should have at least five blocks per station.

In Kekaha, three Bouyoucos blocks are installed for each five acres. These are located several furrows apart from each other at the root zone depth and leads of field military telephone wire are brought to a common readily accessible station on the periphery of the field. Fig. 3 shows a typical station. Taking into consideration the shape of the field and location of access roads or supply ditch pathways, the stations are located to facilitate a quick circuit in the operator's progress from station to station. Where the cover crop does not offer physical impediment to travel within a field, it will not be necessary to run leads to the outskirts of the field. When long leads are not used, the smaller and more convenient Bouyoucos moisture meter (3) may then be used in place of the bridge.

Depending on the layout of the field, a two-man team can cover 100 acres in a half to one hour, including travelling time from station to station. The readings can be made rapidly (less than a minute per reading) and not much skill is required to operate the bridge, although experience is a great aid, especially in obtaining a balance at high readings. Based on experience at Kekaha where two men, each with a bridge, cover nine separate fields widely scattered over the plantation in approximately one-fourth of their working time, it is estimated that a two-man team of operators can cover as many as 30 fields if assigned to the work full time. This is possible because fields recently irrigated need checking only once or twice a week. Only when readings show an increasing level of drying out are visits made two or three times a week. As not all fields are irrigated with rounds starting the same time, visits can be scheduled to take in many fields with ample time left for those requiring more frequent checking.

Interpretation of Readings. If a field has been divided into two or more sections on the basis of wide differences in moisture-equivalent values, a separate graph is kept for each section. The interpretation of readings plays one of the most important parts in the successful operation of irrigation scheduling. It is essential to have a good understanding of the generally hyperbolic shape of the moisture-tension curve. In casual experiments on resistance correlation with soil moisture, it is always alarming to find that while all buried blocks may have very similar readings, when the soil is wet, differences between units may be considerable as the soil dries. This is because the rise in resistance for every per cent loss in available moisture is very gradual at first and then becomes steeper and steeper. Thus, for every 1 per cent decrease in available moisture when the soil is still relatively wet, the rise in resistance may be only 100 ohms, while 1 per cent loss in available moisture when the soil is becoming relatively dry can mean a rise in resistance of as much as 5,000 to 10,000 ohms. This magnification of moisture depletion as the supply becomes more and more critical is a very good point in the method, if understood, and a very bad point, resulting in its dismissal as "unreliable" if not understood, especially when one block may read 20,000 ohms and another 30,000 ohms in the same field because of a difference of 1 per cent in the two locations' moisture levels.

At Kekaha, all readings are first recorded in field notebooks. Depending on the age of the crop, the depth at which the Bouyoucos blocks are located, the salinity of the area, the size of the field and the irrigation performance efficiency obtained, readings are circled in red whenever they are over 3,000, 4,000 or 5,000 ohms. For all normal conditions when the field under control is non-saline and the crop is old enough so that most of its roots have reached the depth at which the plaster of paris units are buried (generally six months old), we use 5,000 ohms as the index point which arbitrarily classifies moisture conditions as relatively wet or relatively dry. A reading of 5,000 ohms is equivalent to one-third available moisture, indicating that two-thirds of the

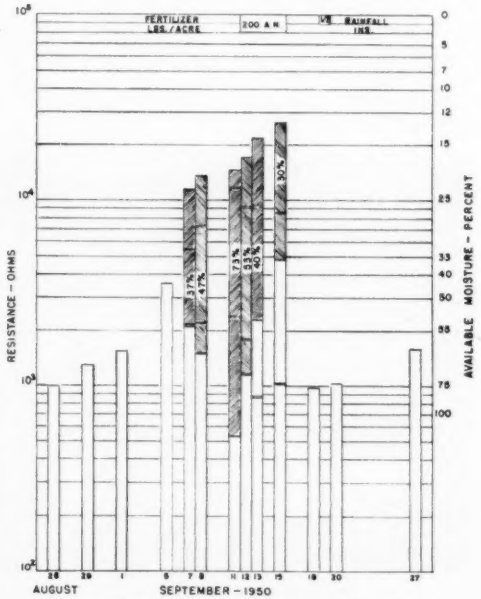


Fig. 4 Moisture variations during irrigation interval

available moisture has already been depleted. Any portion of the field having readings of 5,000 ohms or over is classified as relatively dry; when 25 per cent or more of the total number of installed Bouyoucos blocks in a field read 5,000 ohms or over, then the whole field is said to be relatively dry.

For abnormal conditions, such as mildly saline fields or when the crop in non-saline fields is still so young that the roots have not reached the depth where the units are located and extra Bouyoucos blocks have not been installed at shallower depths for a check, 3,000 ohms instead of 5,000 ohms is used as an index point.

READINGS TO INDICATE MOISTURE STATUS OF FIELD

Circled readings represent the portion of the field which is drying out faster than the rest of the field; this portion is averaged and posted as a percentage of the whole field in the semilog graph as a red column only when it represents over 25 percent of the field (or section). Fig. 4 from the graph of field 22 will be used to illustrate the method followed in recording and interpreting readings. On August 26 readings averaged 1,000 ohms. This is posted as a green column. On August 29 readings averaged 1,300 ohms. On September 1 readings averaged 1,550 ohms. On September 5 a few readings were already in the red, that is, circled because they were over 5,000 ohms, but as they represented less than 25 per cent of the whole area, the circled readings were added in with the rest and the average, 3,600 ohms, of all readings obtained in the field was posted in as a green column. At this stage, the field as a whole had lost 50 per cent of its available moisture because an average of 3,000 is equal to 50 per cent available moisture (Fig. 1). On September 7, 37 per cent of the readings were over 5,000 ohms, and hence "in the red." As this represents more than 25 per cent of the field, the circled readings were averaged separately from the rest, and this weighted average is used instead of the over-all average to indicate the height of the column. The column is colored red for 37/100 part of its length from the top down to indicate 37 per cent of the section is relatively dry and in this area the average moisture available has been depleted to 25 per cent. The average of the uncircled readings, that is, those not yet over 5,000 ohms, is posted as a heavy black line on the same column.

The average of all readings is also posted to indicate the over-all average moisture status of the field. This is the lighter bar at 5,500 ohms. To summarize, data recorded on September 7 as a partially red column would, therefore, at a glance, give the following information concerning the moisture status of the field: Slightly over a third (37 per cent) of it is relatively dry with only 25 per cent available moisture. The remaining area (63 per cent) is still relatively wet with over 55 per cent available moisture left. The area as a whole has only one-third of its available moisture left. From that day on, readings should be taken at sufficiently close intervals (one or two days) to give a representative drying-out pattern which will prove valuable for forecasting or estimating future applications as much as a week to ten days ahead of time on the basis of readings obtained. On September 8, the relatively dry portion covered 47 per cent of the field, and notice to irrigate within four days was given.

On September 11, the area in the red had increased to 73 per cent and the average level of moisture left in this 73 per cent portion has been further reduced to 20 per cent (15,000 ohms). The section was irrigated beginning September 12, and the red portion of columns for September 12, September 13 and September 15 was reduced from 73 per cent to 30 per cent. On the final day of the round, September 15, the last area to be irrigated had dried out to the point where an average margin of only a little better than 10 percent available moisture separated it from the wilting point. The moisture tension at that stage would be approximately 10 atmospheres. The next column on September 18 is back in the green, indicating that the round is completed. However, the efficiency of application was not as it should be in several spots because not all units returned to their lowest readings. The average should be nearer to 700 ohms instead of 1,000 ohms.

The following general rules are followed at Kekaha:

1 *Warning in graphs.* When 25 per cent or more of a field has already used up two-thirds of its available moisture (5,000 ohms level), the weighted average moisture status of this relatively dry portion of the field is used to represent the moisture status of the whole field. Warning of increasing dryness is given by coloring the column red in the graphs.

2 *Notice to irrigation foreman.* By the time 50 per cent of the field has gone in the red, that is, becomes relatively dry and the average of the red readings is above 10,000 ohms (only 25 per cent available moisture left), notice will have been given to start the irrigation round in anywhere from 4 to 8 days. The number of days between notice to irrigate and the date the round is to commence is estimated by observing drying patterns covering the last few rounds as recorded on the graph.

3 *The ten percent available moisture cushion.* The guiding principle in estimating the number of days to lapse between notice and application is to aim for the longest interval without delaying the round to the point that the field may be subjected to wilt before the round is completed. Hence, knowing the acre-per-man-day performance for the field and the area involved, as well as past recorded drying patterns, it is not too difficult to calculate when the irrigation should be started so that is can be finished without having the red or driest portion of the column higher than 30,000 ohms if possible. Generally, if acre-man-day performance is high and the field is small, it is possible to wait until most of the field is in the red before calling for a round. For average irrigation performance in Hawaii, starting a round when 75 per cent of the field is in the red column and the average reading is under 20,000 ohms (20 per cent available moisture), it is generally possible to finish the round without having the last red column go over 30,000 ohms (the 10 per cent available moisture cushion).

GENERAL EVALUATION

The system is very flexible and offers promise of plantation-wide irrigation scheduling without imposing stringent control. Since we do not have most of our fields under the system, we can only say that indications are that it will be a great help in scheduling irrigations on a plantation-wide basis, allowing planning and more economical allotment of water during normal periods and enabling most effective use of the supply on a priority basis in times of shortage. In the fields already under this system of irrigation control, the scheduling of rounds has been made easier because it enables ample notice to be given the irrigation supervisor for the start of a round. In periods following heavy rains, the system has also proved particularly helpful in scheduling the start of rounds. There have been savings in the number of rounds in several fields already and this savings to date in terms of irrigation labor cost has more than paid for installation and operation costs. Although economizing on the number of rounds was never the objective, this has resulted because rounds are applied only when readings indicate their need and not because a fixed number of days interval has elapsed. The appearance of the cane is excellent and compares well with cane in field practice areas. However, only the harvest can tell whether the system's merits, in offering irrigation planning and economy, are matched by good yields. The system is still in the test stage, although on a large-field scale, and changes will be made whenever there are improvements.

Both the system and Bouyoucos blocks used are merely tools. In the hands of one who is familiar with the soil-moisture relationship, they can aid materially in reducing irrigation costs and increasing benefits from other agronomic practices by offering better planning and scheduling of fertilization application and weed control, as well as irrigation control.

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(Continued on page 154)

Flood Control in the Little Sioux Watershed in Iowa

By Edwin Freyburger
MEMBER A.S.A.E.

THE Little Sioux Watershed in northwestern Iowa is one of the few places in the world where there are areas of fertile loess soil reaching down to a depth of 60 ft or more. The loess soil, of wind-blown origin, is one of the most highly productive and at the same time one of the most highly erosible in the Missouri River Basin.

This watershed is subject to high-intensity, localized rains of short duration. During these storms highway bridges and culverts are washed out. Railroad installations along the Little Sioux River and its tributaries often are seriously damaged. Valuable bottom lands are littered with undesirable silt and debris left by the receding floodwaters.

Over-all damage within the watershed and adjacent bottom lands to farm lands, towns, villages and improvements such as drainage ditches, highways, and railroads approaches a million dollars annually. This figure is based on a study of flood and erosion damage at 1935 to 1939 prices, transposed to present-day costs. Open drainage ditches are particularly vulnerable. One drainage district alone, including approximately 50 miles of ditch, recently spent $125,000 in a single year. Almost all the money was spent to remove accumulated deposition.

The Little Sioux Watershed, approximately 135 miles long and some 50 miles wide at its widest point, is located in the northwestern part of Iowa with a small portion of the northern tip extending into Minnesota. It contains 4,500 square miles, covering portions of 15 counties in Iowa and two in Minnesota. The Little Sioux River is a part of the Missouri River system and flows southwest into that river.

The glaciated northern third of the watershed has many lakes. This part is comparatively level and erosion is not a serious problem. The topography through the central portion is rolling with slopes ranging from 8 to 15 per cent. Slopes in the southern part of the watershed gradually become steeper and finally end in abrupt bluffs bordering the flat alluvial plain of the Missouri River. Slopes in this part may be as great as 50 per cent or more. Here, gullies 60 ft deep and often more than 150 ft wide have destroyed large portions of many farms and have contributed to siltation damages far downstream.

The soils throughout the watershed generally are highly productive. The deep loessal soils are to be found in the southern two-thirds of the watershed. In addition to suffering excessive water erosion, the loess soils dry out readily. During a shortage of rainfall, they become so droughty that crops and grass cover are difficult to establish and maintain.

In the Flood Control Act of 1944 Congress approved and authorized the works of improvement recommended in the Report of Survey, Little Sioux River Watershed.* Funds for federal participation in the work have been provided in the annual appropriations. By authority of the Flood Control Act, the Secretary of Agriculture assigned the responsibilities for this flood control work to the Soil Conservation Service. It set up a technical staff in the watershed to investigate the problems, develop technical plans for proposed improvements, supervise construction of improvements, and perform any other technical duties necessary to put the program into effect. An illustration of the cooperative nature of the undertaking is found in the memoranda of understanding between the local soil conservation districts and the U.S. Department of Agriculture. In these memoranda the districts assume responsibility for contracts or agreements with the farm landowners to secure necessary rights-of-way and other local cooperation. The districts also are responsible for certain other duties necessary for executing the program and maintaining the improvements made.

Actual operations were started in the Little Sioux Watershed in 1946. The objective of the work is to arrest erosion on farm lands by improved farming methods and practices; control the major gully problem and, by so doing, prevent flooding and damage to bottom lands from silt and other debris, and to prevent erosion conditions existing in the lower part of the basin from spreading throughout the watershed.

By virtue of the Flood Control Authority, it is the role of the Soil Conservation Service to supply technical supervision, designs and specifications for such construction work. Actual construction is done under federal contract awarded on competitive bids by interested contractors.

Farmers are expected to establish crop rotations, contouring of field slopes, vegetated waterways, terraces and such other related practices as may be agreed under the soil conservation districts' programs. The soil conservation district organization is the local agency, established under state law, to secure the necessary farmer and landowner cooperation and provide for a maintenance program after improvements are installed.

In order to expedite the program, a 12-man working committee was established. It is made up of one district commissioner from each of the 12 soil conservation districts concerned. The duties of this committee are: first, to represent local interests of the Little Sioux Watershed in dealing with

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* House Document No. 268, 78th Congress, First Session

Fig. 1 *(Left)* Outlet of a spillway passing under a public highway • Fig. 2 *(Right)* An open-chute spillway over an earth dam

federal and other agencies in regard to the operations program; second, to make recommendations to the separate soil conservation districts within the watershed as to policies and procedures for carrying out the program, and, third, to be responsible for establishing priorities of assistance for flood control work.

Improvements are made in minor watersheds ranging in size from 500 to 2,500 acres. When the soil conservation district commissioners of one of the districts determine that sufficient progress has been made by a group of farmers in establishing conservation practices on their land, the minor watershed is recommended to the 12-man committee for a priority rating. It is then placed in line to receive *additional* aid from the Soil Conservation Service in solving its major flood and sediment control problems. The actual design and ultimate construction are started only after a minor watershed has been approved by the 12-man committee.

Before construction on privately owned land in any minor watershed is started, landowners within the watershed boundaries are required to make an initial payment equal to 1 per cent of the contract cost, but never in excess of $1.00 per acre, to insure future maintenance of the improvements. This amount is placed in a "district-wide mutual maintenance fund" and is administered by the soil conservation district in accordance with the Act of Congress authorizing the improvement. Additional maintenance funds will be raised in conformance with anticipated needs under plans developed by the soil conservation districts.

Where it is necessary to make improvements on public highways, railroads or other non-farm lands, an agreement of cooperation setting forth the material responsibilities of each is required between the party concerned and the Soil Conservation District.

Before any engineering design work can be started, field surveys must be made. Because of the rugged terrain and the number of structures usually involved in a water-disposal system, much more detailed surveying is required to obtain field data for the necessary topographic maps, profiles and cross sections than might be required for a single earth-fill dam, for example.

When work in the first minor watersheds was started, it was found that new methods would have to be adopted. The rough, irregular topography made accurate engineering surveys difficult. Various new ideas and systems were tried out and the best of these were incorporated in a guide for use by the engineering survey crews. Accurate surveys are necessary not only for engineering design and construction, but also for informing the landowner how his lands will be affected by the completed improvements. The landowner obviously wants accurate information about borrow pit locations, high and low water elevations in reservoirs and any other factors affecting his property so that he can better participate in the planning of the control measures.

Incidentally, the landowner donates the necessary land for the water-disposal system and gives free rights of ingress and egress to the Soil Conservation District. Neither the Soil Conservation District nor the government purchases rights-of-way or pays damages for lands occupied by structures, either when completed or occupied during construction periods.

After the engineering surveys are completed and the data plotted in suitable form, the hydraulic design of the water-control system is made. This often is a tedious cut-and-try process. It involves determining the number, kind and capacity of structures to be used and their location with relation to each other. The layouts usually require a combination of vegetative waterways, diversions, drop spillways, drop inlets and chutes.

Soil borings and other foundation investigations are made when the structural sites have been determined. Structural controls involving earth fills require some sort of toe drainage system in almost all cases. This is because groundwater accumulations from adjacent land or seepage water from the reservoir above the earth fills may percolate around or through the undisturbed abutment sections, causing sloughing and instability of slopes. This seepage condition may occur, even when the structure is used for temporary storage purposes only, with no permanent pool. Under these conditions the seepage comes from the adjacent land. It may not be in evidence during dry periods, but will show up during wet seasons to plague the engineer if he has not provided for adequate drainage.

Hydraulic designs are based on controlling slightly more than 3 in of actual runoff. While this figure may appear low to builders of large dams, it was determined that this amount is about the economic maximum for this kind of work in the Little Sioux Watershed. Runoff is flood-routed at all detention dam sites to determine size of spillways required in relation to available storage. It also provides a means whereby the outflow of one detention reservoir into one further downstream can be controlled so that it does not overload the spillway of the lower detention dam.

Structure spillways may be of the full-flow type which provides for no reduction in capacity by virtue of spillway storage, or they may be of smaller capacity allowing for a longer period of flow in which to pass a given quantity of water temporarily detained in a pool above the spillway.

When detention reservoirs are used, the probable rate of sediment accumulation is calculated and allowed for in the design of the structure. Sedimentation studies made only recently by the Soil Conservation Service on some 30 reservoirs along the Missouri River in Iowa, Nebraska, and other states indicate that the rate of sedimentation accumulation in a specific reservoir may be estimated on the basis of size of watershed, rate of erosion in the watershed and the storage capacity-watershed ratio†.

After the hydraulic design has been completed and laid out on suitably matched site maps, they are forwarded to the structural design section where the necessary structural layouts and details are made, including specifications for actual construction work. All main spillways in a water-disposal system consist of monolithic reinforced concrete or reinforced con-

† Sediment Design Criteria for the Missouri Basin Loess Hills, SCS-TP- 97

Fig. 3 *(Left)* Flood-detention dam showing entrance of drop-inlet spillway near top of embarkment and trash rack over draw-down spillway below • Fig. 4 *(Right)* Storm water temporarily collected in a detention reservoir behind an earth dam having a draw-down spillway

crete pipe, the latter supported on concrete cradles to insure good alignment and support. Some metal pipe is used for side-drainage spillways and in toe-drainage systems. It is sometimes used for outlet sections at the discharge end of some pipe-drop inlets. Since the beginning of the work in 1946, numerous standard designs have been developed which, once designed and drafted, can be used over and over again.

Since construction work is done on contracts secured under competitive bidding, specifications and engineering plans must be complete and devoid of errors in so far as is humanly possible. Specifications must be prepared separately for each minor watershed, but may include standard paragraphs that can be used in practically all specifications. Wherever possible, standardization is attempted in order to eliminate engineering and clerical work.

Earth-fill materials are placed under controlled moisture conditions and compacted with sheep-foot rollers to minimize settlement and attain a density of embankment to meet design requirements. The dry weight of the undisturbed fill materials is in the neighborhood of 75 to 85 lb per cu ft. Optimum compaction is obtained when the moisture content is between 17 and 22 per cent, depending on the percentage of clay, silt and sand. The dry weight of the embankment material after compaction ranges between 95 and 110 lb per cu ft. It has been found that the compacted material provides a much better foundation upon which to construct spillways and is less subject to settlement than is the undisturbed soil.

Contractors are under bond with regard to completing the work in line with plans and specifications and within the time period specified. Materials and actual construction are closely checked by inspectors employed by the Soil Conservation Service. Payment to contractors is made on a percentage basis or work completed, until the job is finished when final payment is made.

When the construction work has been completed, the minor watershed and its improvements are turned over to the landowners and the soil conservation district for maintenance purposes. The Soil Conservation Service assumes no obligations other than technical advice after the construction work has been completed and turned over to the district.

The majority of the work done and accomplished thus far has been in the Cherokee, Ida, Monona, and Woodbury soil conservation districts involving around 1,625 district cooperators.

Construction priorities have been established in 28 minor watersheds. Construction work in eight minor watersheds involving 71 structures of different types has been completed. Four other minor watersheds involving 74 similar structures are being constructed. In addition to these accomplishments, 627 miles of terraces have been constructed, 127,000 acres of farm land contoured and 422 miles of grass waterways have been established.

Flood-control benefits alone, as related to water damages, are considered to be largely of a local nature in the Little Sioux Watershed. No claims are made that the work being accomplished will aid in reducing major floods on the Missouri River. However, flood damages in the watershed of the Little Sioux will be materially reduced. Flash storms over small areas may occur causing upstream damage when the flow in the Missouri or Little Sioux River itself are far below flood stage. Obviously, water-control benefits accrue mainly to local villages, towns, highways, railroads and farm lands. On the other hand, the reduction of sediment which eventually would enter the Missouri River is an off-site benefit that was not evaluated in the survey report.

Field Irrigation Scheduling

(Continued from page 151)

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Painting Metal Roofs with Zinc

WIRE brushing a rusty, galvanized roof, preparatory to painting with metallic zinc paint, appears to be economically unsound as well as time-consuming and laborious, according to actual farm tests by the American Zinc Institute. Instead, its field engineers report, thorough brushing with a stiff-bristled fiber push broom to remove loose rust and scale gives a surface on which a single coat of the zinc paint — brushed or sprayed on — will endure five to six years in ordinary rural atmospheres, two coats for 12 years or more.

Perfect preparation of the surface, which is compulsory in most painting operations, would require wire brushing, but years of MZP testing in normal roof exposure in Midwest states proves that the results are only slightly better, if any, than those obtained with an ordinary barn broom. Certainly it appears that wire brushing fails to increase service life enough to justify the added expense in time and labor.

It is theoretically best to paint farm building roofs of zinc-coated corrugated steel before actual rusting begins — when dark areas are first observed here and there over the surface. With ordinary roofing, this appearance will develop usually after 10 to 12 years' service. However, Institute engineers generally recommend painting when 10 per cent of the surface has weathered sufficiently to show rust. If only spots of rust have developed, give them a coat first, then paint the entire surface.

Best time to paint is in warm, dry weather when the paint will spread well and dry readily. Paint should not be applied when rain is threatened, or when the surface is damp with dew.

Hand brushing is the simpler and quicker method for small jobs. Paint may be brushed out, but the thicker the film (so long as the paint does not run) the longer the life of the zinc coating whose function is to protect the steel sheet.

A Rapid-Transfer Engine Unit for Farm Machines

By K. L. Magee
MEMBER A.S.A.E.

THE tremendous advancement of American agriculture over the past century is due principally to the development of the many tools and machines through the application of power. At first this advancement was slow. Tread or sweep horse power was converted to rotary motion to run such machines as threshers and feed grinders. Then steam power replaced horse power and eventually the internal-combustion engine replaced steam.

This all seems very categorical, but it was not until after the development of the internal-combustion engine and its application to tractive power that the big change took place. As tractors began to replace horses on the farm, it became only natural to find more ways and means for utilizing this newly found power to reduce cost, increase productive capacity, and eliminate many of the drudgery tasks about the farm. The rapid strides in this direction have been made principally in the last 30 to 35 years.

Logically it fell to agricultural engineers to accept the task of improvement of the power units, the tools and machines to utilize the power, and new farm methods and techniques to secure the maximum benefits of the power and equipment. This task has not been an easy one. There has been a constant tug-of-war between the adaptation of machines to power, and vice versa, and always the aim has been to secure the maximum amount of work at the minimum cost.

Available power and versatility of equipment quite naturally prompted engineers to conside several operations together in one single operation, such as cutting and threshing grain, baling hay from the windrow, and more recently handling green crops from the field with forage harvesters. Engineers have also applied power through machines to replace hand operations such as corn picking, and have converted many ground-driven machines, such as mowers and binders, to power-driven units to secure more positive and effective performance.

Power-driven machines require some power source for operation, and through the years of development we now have power-take-off units on tractors whereby tractor engines are utilized to run machines through shafts from the tractor to the machine, and independent power units for the machines only. Discussion of the relative merits of these units may be appropriate on some occasion but has no particular value here. They merely exemplify the trends in development and portray the responsibility of the agricultural engineer in providing equipment for the utmost use at the lowest cost.

The rapid-transfer engine unit for farm machines is one type of independent or auxiliary engine power that can be transferred easily and quickly from one power-driven machine to another. It is another step to bring up-to-date the search for easier and cheaper ways to do things. It is an answer to the question often raised by farmers and propounded and discussed more or less periodically in the meetings of the American Society of Agricultural Engineers: "Why can't an engine unit be developed that can be used interchangeably on more than one machine with a minimum of tools, equipment, effort and time required to make the change, so that investment can be reduced and the unit used for a greater period throughout the year?"

The fundamental construction of the engine unit consists of an engine with base frame, pivot mountings on one side of the frame for attaching to the machine, a rocking beam with caster wheels on the opposite side of the frame and a small gearbox for speed reduction and change of rotational direction.

Machine mounting is done on a special frame attached to the drawbar. The mounting frame has U-shaped attaching brackets for the trunnions on the engine frame and retention is made by pinning in place.

Power is transmitted from the engine unit to the machine through a standard power-take-off gearbox and the connection between the engine unit to the gearbox is through a power shaft of the telescoping type used between tractors and machines on power-take-off-driven machines. The A.S.A.E. safety features are incorporated in the shield and shaft.

Figs. 1 and 2 show a typical mounting on a machine. Fig. 1 shows the drive features and the rocking beam with caster wheels. Fig. 2 shows the mounting to the machine, and Fig. 3 shows the mounting frame on the machine. The first two figures show how the unit conforms to ground-surface changes. The main frame moves in the trunnions on the machine for changes that affect the relationship between the ground and the machine drawbar. The rocking beam accommodates the changes between the caster wheels. The caster wheels of course are for turning.

Fig. 4 shows the unit off the machine and a partial view of the transport tongue used for towing or moving from machine to machine.

The process of removal from a machine involves only a few operations. Insert the tongue and pin in place, set the wheels in the position shown and pin to prevent swinging on the pivots, lock the oscillating beam with a pin, disconnect the power shaft at the engine end, and pull the pins in the mounting frame on the machine shown in Fig. 3. A stand is incorporated in the frame on the side opposite the tongue for stability when not attached to a machine.

Mounting is done in the reverse order of the procedure just described.

The belt on the unit serves as a clutching mechanism.

The choice of the input shaft of the power-take-off gearbox as the point of application of power is very simple. It is the only shaft on driven machines that is governed by any standard speed.

The illustrations show the possibilities that can be explored in utilizing the unit for stationary work either through a shaft or by belt from a pulley attached to the power output shaft. This set-up suggests many uses such as operating elevators, hammer mills, etc.

Thus it is possible not only to solve the question of rapid transfer of engine units from machine to machine, but to provide a setup whereby such units can be utilized more extensively for many farm applications aside from field machines.

The advantages of this rapid transfer engine unit are:

1 Ease of transfer from one machine to another.

2 Availability for stationary power on many farm jobs.

3 Requires no specially designed machine for adaptation.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1950, as a contribution of the Power and Machinery Division.

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4 Much of the weight is carried on the wheels which are a part of the unit; consequently, the machine design is simplified.

5 Engine weight tends to balance draft load on tractor drawbar by reducing ordinary side draft common to most field machines.

6 Unit mounts directly to machine independently of tractor and does not affect relationship between tractor and machine.

7 Does not affect maneuverability of machine.

I submit the rapid transfer engine unit for farm machines as an immediate solution to the physical and economic problems of the adaptation of independent power-driven farm machines where such power is now necessary or desirable. I submit this unit also as a factor in the further development of more useful and economical power for farm operations. There is still a challenge to agricultural engineers in this particular development.

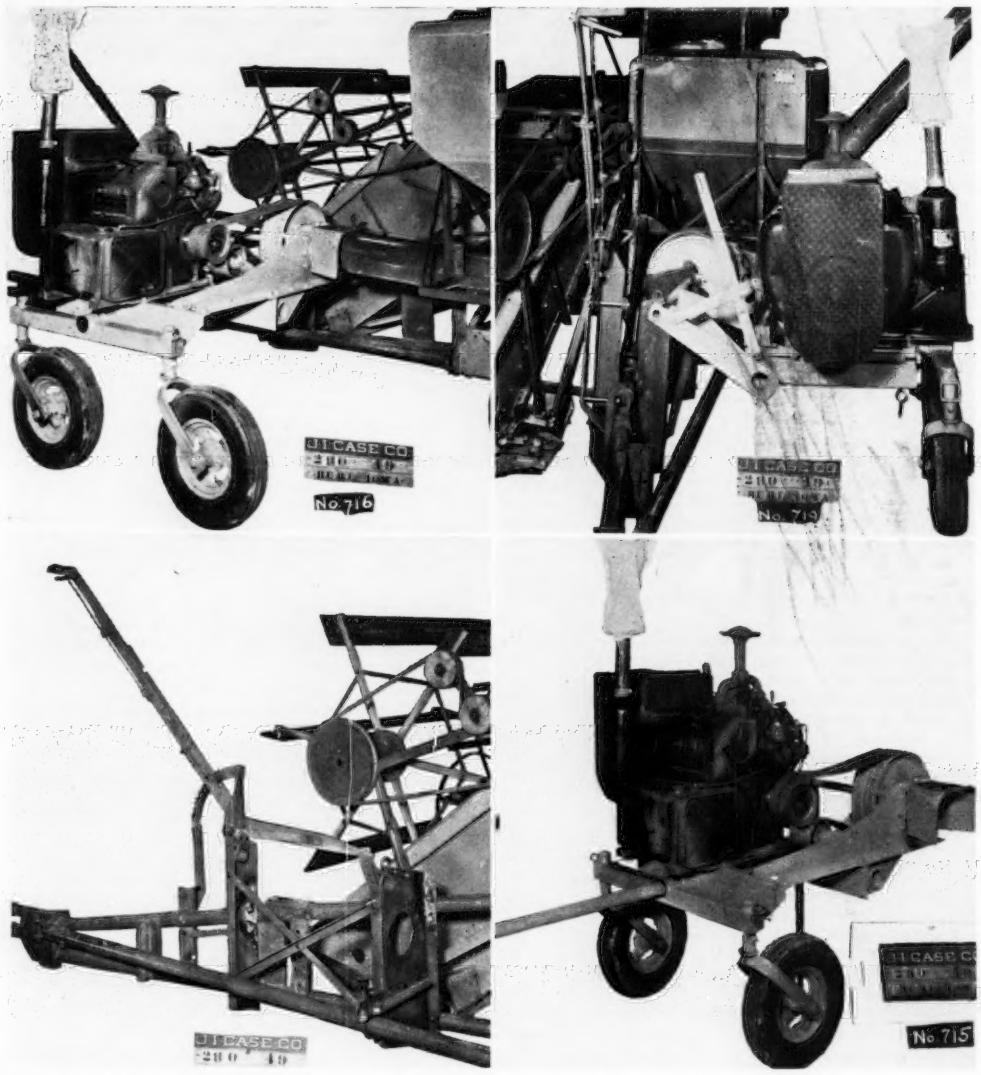
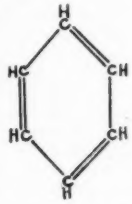


Fig. 1 Side view of typical mounting of rapid transfer engine unit on a combine showing power transmission features and the rocking beam with caster wheels • Fig. 2 Front view of typical mounting on a machine illustrating the method of mounting and the belt clutch • Fig. 3 View of the mounting frame on the machine to which the engine unit frame is pinned and on which it pivots • Fig. 4 View of engine unit prepared for transport or for use as a stationary power unit showing the transport tongue, caster wheels locked in position and the stability leg attached at the rear of the engine frame

Use of Aromatic Solvents in Aquatic Weed and Pest Control

By Geo. Yuan Ewart
MEMBER A.S.A.E.

THE term aromatic solvent refers to such oil solvents as naphtha, paint thinner, benzene and dry-cleaning fluid. Technically speaking, it applies to benzenelike derivatives of petroleum and coal tar. Benzenelike refers to similarity to benzene's structural formula in that such solvents also have the same hydrocarbon structure as a nucleus. Examples are toluene (mythyl benzene); CH_3; benzl alcohol, CH_2OH; bromobenzene, Br; xylene, CH_3. The accompanying hexagon represents the structural relationship of hydrogen and carbon atoms in benzene.



A chlorinated hydrocarbon compound, developed and marketed by the Chloroben Corp. of New Jersey under the trade name of Benoclor 3C gave effective control of aquatic weeds in large-scale tests conducted by the U.S. Bureau of Reclamation from 1943 to 1948 in several irrigated districts in the West (3)*. Because of the relatively high cost and its high specific gravity (necessitating frequent application stations because of a tendency to settle out too quickly), the Bureau conducted a research program to find an effective but cheaper substitute. In May, 1948, (5) the *Reclamation Era* carried a report on the effectiveness of emulsified naphtha as an aquatic herbicide. During that year more than 100,000 gal of this aromatic solvent were used by both federal and private groups for eradication of water weeds(2).

The Bureau of Reclamation gives the following specifications as a standard to which material to be used should conform (2):

	Type A	Type B
Flash point, degrees F, not less than	80	80
ASTM D-86 distillation, degrees F		
Starting point	278	275
Not more than 10 per cent	286	—
Not less than 90 per cent	395	333
End point, not higher than	420	360
ASTM D-875 aromatic, per cent, not less than	85	75

Materials of either petroleum or coal-tar origin conforming to the above specifications are available at costs ranging from 29c to 70c a gal, delivered to the Territory of Hawaii.

Since May, 1948, the Kekaha Sugar Company, Ltd., has conducted laboratory and field studies of various hydrocarbons carrying different per cents of aromatics as well as different types and different proportions of emulsifiers. We now use an aromatic solvent produced by Standard Oil Co. and sold under the trade name Socal No. 3. This, along with their Socal solvents, Nos. 1, 2 and 355-L, are low-aniline petroleum solvents of medium-high boiling range. Although it is sold mainly for use as thinner for synthetic enamels and lacquers, the per cent of aromatics which are high, especially in Socal No. 3, make it very suitable for use as an herbicide. It may be pointed out that, generally speaking, the proportion of aromatics determines the effectiveness of such solvents for herbicidal use. The higher it is, the more effective it would be provided that such other characteristics as rate of evaporation and settlement measure up to standard.

In the specifications above, Type B should not be used where the water temperature is below 70 F.

Typical test standards of California aromatic (low aniline) solvents are given in the following specifications for four of the Socal solvents:

Socal solvents	No. 1	No. 2	No. 3	No. 355-L
Flash point, deg F, not less than	Below 75	90	142	112
ASTM D-86 distillation, deg F, starting point not more than 10 per cent	230	286	362	332
not less than 90 per cent	270	310	384	370
End point not higher than	292	332	404	397
ASTM-D, aromatics, per cent, not less than	75	87	89	55

A comparison of the Socal solvent specifications with those prescribed by the Bureau indicates that Socal No. 3 is very suitable. The higher distillation temperature for all fractions, even the initial 10 per cent, makes it especially suitable for use in higher-temperature regions.

Emulsifiers. Aromatic solvents are not miscible with water and require an oil and water-soluble emulsifier. According to the Bureau, most oilsoluble petroleum sulfonate emulsifiers (also referred to as mahogany soaps) will give adequate emulsions at relatively low cost. It has been our experience, however, that not all sulfonates emulsify aromatic solvents readily. The two found most suitable are Triton X-100 (Rohm & Haas) and Atlas G-1096. A new cationic type of wetting agent recently introduced by the Carbide and Chemical Corp. as Amine 20 has proved effective in concentrations as low as 0.1 per cent. These will give stable emulsions when added in concentrations as low as 2.5 per cent. The emulsifier should be added gradually while the aromatic solvent is being mechanically paddle-agitated. It is also advisable to pump the mixture through a large orifice nozzle under high pressure (over 100 psi) continuously back into the mixing tank for 15 min while the paddle agitation is going on. This whole process can be done in the spray truck itself if it has a paddle agitator connected to the pump drive.

Equipment. For small applications, portable knapsack pressure tanks which will withstand 175 psi pressure may be used. Surplus air force oxygen tanks may be converted to this use by welding on a tire valve. After filling it two-thirds full, pressure can be introduced either at the service station where a compressor-fed air hose is available or by hand pumping.

For larger applications, it is best to use a spray truck equipped with a large storage tank (paddle agitated), a pump with an open by-pass system, a 30-ft boom and/or a reel of 200-ft high-pressure hose. Plans for such a truck have been published by the Bureau (2). Because aromatic solvents will readily dissolve petroleum grease, pumps should be lubricated with silicon grease.

Nozzles which are equipped with screens and deliver either a cone or fan-shaped spray should be used. Tee-Jet nozzles of No. .002 are suitable for small flows but where a heavier application is needed to maintain effective concentration, such as treatment of streams where the velocity of flow is high, it is better to use larger orifices such as the Tee-Jet No. .004. Nozzles should be spread along a boom not more than 2 ft apart when treating wide channels in sections where there are no culverts, gates or weirs. However, wherever such turbulence-creating structures are located, it is always best to mass nozzles for a concentrated delivery at these points, because a better mixing of the herbicide and water will result. A box of spare tees, unions, plugs and short-threaded sections of pipe should, therefore, be carried on the truck so that nozzles can be fitted to meet the various conditions found.

Hose and all rubber fittings should be inspected periodically because aromatic solvents attack both natural and synthetic rubber. Although some of the synthetic hose, such as neoprene, are more resistent to deterioration.

Preparation for Treatment. A concentration of at least

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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*Numbers in parentheses refer to the appended references.

300 ppm of the herbicide should be maintained in treated channels for at least 30 min. Two factors, time and pump pressure, will control rate of discharge if rate of ditch flow and nozzle orifice size remain constant. To conserve material, the rate of ditch flow should be reduced as much as possible before application is made. The velocity of this minimum flow should be measured either by current meter or by timing a float's travel over a given length. Knowing the approximate area of the wetted perimeter (width x depth) and the velocity, it is possible to determine the discharge ($AV=Q$ cfs). To achieve the concentration required (300 ppm) for the minimum time required (30 min), 4 gal of material must be pumped into the water for each cubic foot per second of flow. This is calculated from the following equation:

$$\text{X gallons herbicide} = \frac{\text{cfs x 450 x 30 x 300}}{1{,}000{,}000}$$

In the above, (cfs x 450 x 30) converts the flow rate from cubic feet per second to gallons per 30 min. The rate of nozzle discharge under various pressures may be obtained from the manufacturer's handbook. If this information is not available, nozzles can be rated by having them discharge into gallon cans under various pressures and a curve can then be drawn. For best dispersion, pumping pressure should be at least 40 psi.

Spacing Applications. The presence of structures which constrict flow and thus create turbulence would, to a great extent, determine the location and spacing of stations. The first station should be several hundred feet above the section to be treated so that the chemical can mix more thoroughly with the water before reaching the treatment area. The better dispersed the material is in the water the more uniform will be the resulting kill.

Nozzle placement will significantly affect uniformity of dispersion. Nozzles should be submerged to discharge at least 4 in below the water surface. They should also be placed to face *against* the direction of flow. Channel to be treated should be shut off from all lateral discharges into it along the course to be treated to prevent dilution and channeling of treated water away from weed stands down stream of such lateral discharges. If all these precautions are taken, it is not necessary to apply the material at too many points. Uniformly dispersed material can effectively clean a mile of ditch 25 ft wide from a single station. The second station should be set up to give booster shots approximately half to three-quarters of a mile below the first and an application equal to only half of the first station's will be necessary. Observation will help in determining also where booster shots should be applied because the water which is milky white when freshly treated will be slightly tinged with green and become less milky in appearance as the chemical is being absorbed by the weeds and treated surface as well as reduced by evaporation.

Where weed growth is dense a large quantity of chemical is needed to give a good kill. In Kekaha, ditches 25 ft wide received as much as 350 gal per mile for first applications and as little as 100 gal per mile for routine shots when growth has not gotten out of hand. Long-neglected ditches with little grade may become so completely infested as to become static and should be mechanically chain-dragged to open them up before treatment.

For irrigation ditches, the high velocities of flow will make treatments prohibitive in cost unless the flow is first reduced to a very low point. When concrete-lined ditches with no slope are infested along the sides as well as bottom, they should be sprayed with a previously diluted solution of the material after the section to be treated has been emptied and sealed off from water. The chemical should be allowed to remain on the weeds for as long as possible before water is turned in treated ditches. Applications may perhaps be best done on week ends.

When ditches are first treated, it may prove more economical in the long run to follow up the first treatment with a second as soon as a week after, especially if the infestation is heavy. After a ditch is clean, maintenance applications may be necessary four or five times a year, mostly concentrated in the summer months as long as seeds and weeds from untreated areas are allowed to flow into treated sections.

PEST CONTROL

The discussion so far has been on control of aquatic weeds. It must be pointed out that inasmuch as the material is toxic to most forms of water life, crayfish, snails, toads, frogs and fish will also be killed. In the case of fish and Bufo this is regrettable, but because the material is highly aromatic, only a small proportion of these fast swimming forms are killed because of their ability to swim away from the treated area. In the case of snails and crayfish, the fact that these pests are killed simultaneously with the eradication of water weeds is very desirable. Crayfish undermine earthwork dams, reservoirs, and ditch banks by their constant burrowing, and heavy seepage, even failures, have resulted from them. McBryde Sugar Company is perhaps one of the very first plantations in the Territory to use aromatic solvents for crayfish control in reservoirs. They reported a 100 per cent kill. Crayfish, with burrows measuring as much as 3 ft deep, with a network of laterals leading away from each burrow were found in their reservoirs. In the case of earth bank ditches, the eradication of crayfish, along with water weeds in them, is a "bonus" of inestimable worth. Several foreign countries, notably Egypt (2), are now successfully using the aromatic solvents for eradicating snails. In rice land and in taro patches, especially, this may prove very desirable.

The concentration need not be as high as that suggested for weed control as we find that even toward the tail end of an application when the concentration is too weak to kill aquatic weeds, crayfish and fish are killed. In reservoir treatment, it may be best to empty the reservoir as much as possible first and then add enough emulsified aromatic solvent in to give whatever water remains a concentration of 150 ppm (i.e., if a million gallons of water are left, add 150 gal of material). However, as many crayfish would be in their burrows at the time the water is lowered, these will be above the treated water line. They may be eradicated by filling the reservoir shortly after the treatment (an hour) and adding booster shots to water discharging into the reservoir so that concentration is maintained. An alternative would be to spray the banks above the treated water line with a prediluted solution of 150 ppm if a truck equipped with a long hose could be brought into position for the task.

In so far as toxicity effects of treated water on economic plants are concerned, the USDA (2) found no damage whatever on lettuce, lima beans, orchard grass, ladino clover, spring wheat, potatoes and sweet corn when treated with 300 ppm concentrations. In fact, in nearly all of the above cases (corn, orchard grass, ladino clover, wheat and potatoes) repeated treatments with concentrations five times as great (1500 ppm) resulted in no damage. Lettuce showed 37 per cent damage after 5 treatments with 1280 ppm concentration. Tests at Kekaha showed no damage to cane when 2000 ppm concentration was used to irrigate it successively for five rounds. Other tests, also by the USDA (4) made on animals indicated that sheep and cattle forcibly fed aromatic solvents (Benoclor 3S) were unaffected by 1333 ppm concentrations after repeated dosages. It took repeated concentrations of as high as 6000 ppm to make the animals sick, although they recovered, with no apparent ill effect, six days later. It must be remembered that treated canals will have concentrations of only 300 ppm and that the treated water is so aromatic and unpalatable that animals will not drink it of their own accord.

Promising results have also been obtained in preliminary tests with full strength Socal No. 3 (not emulsified) and dilutions up to 1:5 in eradicating and controlling Johnson grass and manienie. More work will have to be done here before we can ascertain whether such solvents will prove economical herbicides. However, recent work by the Bureau (1) suggested effective control of Johnson grass with 160 gal per acre for the first two treatments and only spot applications of 20 gal or less for follow-up work. *(Continued on page 160)*

Recent Farm Machinery Developments in Germany

By Wolfram Sack

IN DISCUSSING the development of farm machinery in postwar Germany, it is important to point out how people farm in that country because there is quite a difference between farming in the United States and in Germany. Most of the soils of Europe have been farmed several centuries, and that means the yields per unit of land would be very small if the soil were not treated very carefully and if it were not always restored with fertilizer. Therefore, most farmers employ a long crop rotation period. One seldom finds that the same crop is grown on the same field within four years, but on a soil which is very favorable for a certain crop this crop is sometimes raised after only two others in the meantime. To maintain this crop rotation, a certain number of fields is necessary and therefore fields are small compared with the total acreage of a farm. The number of different crops is comparatively high.

This large variety of crops on small fields is the reason why farmers in Germany cannot afford highly specialized machinery for the different field work to such an extent as farmers in the United States do. Farmers need machines for more than one purpose. For example, nearly all the potato and sugar beet farmers have one digger with different tools for doing both jobs of digging. Cultivators are used for cultivating beets, potatoes, field vegetables, and other crops, even planting has been done with a cultivator and special seeding equipment.

The use of fertilizer became very important in the last half century. Many of the farmers get their soil from time to time analyzed and regulate the use of different fertilizer.

After World War II the farm machinery producer faced a very changed market for his products. On the one side the main farm land in eastern parts of Germany was socialized. All farms over 400 acres were divided into small ownerships, mostly of 20 to 41 acres. This number of acres is scarcely enough to support a family. Tractors and machinery are supposed to be in a machine station under care of a mechanic and are available to the heaviest field work for the peasants. Production of this larger sized machinery and also of small machines for the individual peasant is provided in a government program. In the western part of the country where the population is employed to a much greater extent in industry nothing essential in farm structure is changed, but here the average size of farms is not so large.

Despite this geographical distinction in market situations the producer of agricultural machinery in both districts faced a tremendous demand for his product caused by the acute shortage of machinery during wartime and the very high income of farmers, who in the time of food shortage after the war could charge nearly any price he wanted for his products. This demand can only be satisfied very slowly since on the one side a rather high percentage of factories was still destroyed and could not produce at full capacity, and on the other side raw material, particularly steel, were not available in sufficient quantity. Since the changing of currency in the summer of 1948, the economic situation in the western part of Germany is improving.

In the first three postwar years two reasons prevailed to keep the production of the old prewar models of farm machinery. First the shortage of machines available to buy was so great that most of the farmers did not ask what type of machine they could get, if they could only get one. Some farmers bought machinery only for a monetary investment and never worked with it. The second reason is no inventor had any security for his invention, so most of the new experimental machines never appeared in public. Now, speaking of West Germany only, these two reasons exist no longer. Farmers now want to get maximum returns with new labor-saving and multipurpose agricultural machinery for not too high prices.

The most important improvement of postwar tractor models in Germany is the attachment of a hydraulic power lift. This attachment with a new line of implements mounted at the rear end of the tractor is part of the production program of the Lanz Company. The tractor now produced with high wheels for high clearance is in general the same as the prewar model, a one-cylinder, two-stroke diesel engine, crankcase scavenged without any valves. The same arrangement of engine and transmission is used for a 20, 25, 35, 45, and 55-hp tractor. The power lift consists of a parallel linkage on which the different implements can be attached. The working depth of the mounted implement can be regulated by a touch-control lever at the driver's seat. Implements have been built—a side-delivery rake, a two-bottom, two-way plow, a sugar beet cultivator, three different implements for potato planting and cultivating, and a lawn mover.

Besides the old model of a rigid harrow a flexible harrow is on the market. It is a harrow knitted out of about 3/8-in diameter spring steel rods and has the advantage that on each spike only the weight of one of the knitted members lies. This harrow works equally always no matter how uneven the surface might be. It is used for weed control in all kind of fields, potato cultivating and seedbed preparation.

Two new machines are now available for hay harvesting. The Lanz Company builds a side-delivery rake mounted to the 25-hp tractor with two small supporting wheels at the end of machine. This rake has the advantage that the angle between the axis of the rotating drum and the direction of travel can be easily changed. The rake can deliver the hay to both sides, and also, if used in perpendicular position to the direction of travel, can turn the hay for better drying. The other machine is a power-take-off-driven pulled-type pickup baler built by the Claas Company. It delivers twice twine-bound bales of 20 to 60-lb weight to a wagon pulled behind the baler. The hay flow goes straight through the machine without changing direction. The power requirement is a 30-hp tractor. Two men, one at the tractor and one at the wagon loading bales, are required. The machine has a capacity of 4.5 to 6.5 tons of baled hay per hour. It also can be used as a stationary baler behind a thresher.

The Claas Company also builds a new medium-size power-take-off-driven combine. This machine is newly developed since the war after gathering experiences with a not very efficient type of combine in prewar times. The combine is built with a 7-ft cutter bar and for export purpose with a 10-ft cutter bar. The platform with cutter bar is attached on the right side of the machine and can be put upright when the machine is transported. The combine has rubber tires and a baler at the rear end. The straw is dropped on the ground in singly or doubly twine-bound bales having a weight of 25 to 50 lb. For pulling the machine a 35-hp tractor is required. This combine has an average capacity of 3600 lbs of grain per hour. The grain is filled in sacks at the top of the combine, so that the grain sacks can easily be moved to a trailer or truck at the head end of the field. Two men are necessary to operate the combine. With this machine 2 to 2.5 acres have been harvested in one hour. A special built wagon can be connected to the combine in order to collect the chaff and the weed seeds in the chaff. This is a very important operation for weed control. With different designed platforms the combine can be used either in grain fields or for pickup combining or for stationary threshing. These features are very important since using the combine as a thresher during winter time increases the yearly use and hence decreases the operation costs.

The next category of new farm machines is potato and sugar beet diggers. Both kinds of harvesters are mentioned together since almost all diggers are designed so that tools for

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either potato or sugar beet digging can be adjusted. For farms with larger acreage of both crops two new diggers are available. The first produced by the Lanz Company is a very well-designed chain-elevator-type digger. This machine requires a 25-hp tractor and is also power-take-off driven. The machine has two elevator chains and digs either two rows of potatoes or two rows of sugar beets with the respective tools. Its capacity is given as 12 to 20 acres in a 10-hr day. It is equipped with a power lift driven by the power take-off and with an operators seat and a steering mechanism that is only used for sugar beet harvesting in unleveled fields. A gear reduction box is provided which also enables the operator to change the direction of the elevator chains in case of obstruction. The whole body is made out of sheet iron and forged steel pieces arc-welded together.

The second type of digger, built by the Sack Company, can be used for either one row of potatoes or two rows of sugar beets. In this machine after lifting up the potatoes and soil by a digging tool, the potatoes are separated from the soil by two sieves shaking in the direction of travel. The potatoes then are dropped on the ground and lie on the top of the loose-sieved soil. With a 22-hp tractor the digger is able to harvest 10 to 14 acres of potatoes in 10 hrs. The two sieves shaking in opposite directions to each other are attached on special wooden springs to the frame of the machine. The digger is power-take-off-driven and also produced in a bigger size for 2 rows of potatoes. Very successful attempts have been made to extend this type of digger to a potato combine. The same original digging mechanism is employed but at the end of the rear sieve all potatoes, stones, and what is left is lifted up by an elevator to about 7 ft high. From there the potatoes fall over different cleaning devices which separate the vines and the rest of the loose soil. The potatoes then are lifted by an elevator to a hopper at the top of the machine which can be tipped over into a truck at the end of the field. For digging two rows of sugar beets the same machine is used with interchangeable tools and sieves. Eight acres of potatoes were harvested in 10 hr with a 25-hp tractor, one tractor driver, and one operator at the machine.

VINE CUTTER USED IN HARVESTING EARLY POTATOES

For harvesting early potatoes with long vines a vine cutter is attached at the left side of the digger. It consists of a horizontally rotating axle with knives cutting the vines in pieces small enough to fall through the sieves. Since this digger collects stones as well as potatoes, it is only fit for fields with a small amount of stones. For worse conditions the same machine is equipped with a horizontal conveyor to the right of the machine instead of the elevator and hopper. On this conveyor stones and clods are separated from the potatoes by four people standing on both sides of the conveyor and riding on the machine. The potatoes then are filled in sacks or baskets and are set on the field. Both types are built with a steel-pipe-welded frame, are power-take-off-driven, and are equipped with two large tires. The man-hour requirement and the potato losses compare very favorably with the old type of potato harvesting, that is, picking the potatoes up by hand after digging with a machine. Both machines are produced in very small numbers more or less as experimental machines.

Last year for the first time a two-row potato combine was tried. The machine combined both principles of the two other diggers. The machine is in construction very similar to the other diggers. Certain improvements have been made. The potatoes were about 50 per cent separated from stones and clods automatically, and the rest was done by operators riding on the machine. It was possible with this digger, a 45-hp tractor and 5 to 6 men, to harvest 12 to 16 acres in 10 hr. The potatoes were so clean that they were sold without any further processing immediately after harvesting. The stones picked up with the potatoes are collected in a box and were dumped at the end of the field. This machine is also suitable for harvesting three rows of sugar beets. Climate conditions in Germany favor the yearly use of these combines, since in the same region early, medium and late potatoes are grown. In years with not too unfavorable weather conditions these combines can be used for custom work in potato and beet harvesting 75 to 90 days a year.

This report on new farm machines in Germany is not intended to give a complete picture of all new machines, since the author had no opportunity to see all new machines working or to get material on them. Nevertheless the majority of important new machines has been mentioned.

Aquatic Weed and Pest Control

(Continued from page 158)

SUMMARY

Aromatic solvents are economical and effective for eradicating aquatic weeds and pests with little danger to economic plants and cattle or sheep. It may also show promise in land weed control. Socal No. 3 has been found to be a very good aromatic solvent for the purpose and both Triton X-100 and G-1096 give good emulsification at only 2.5 per cent in higher temperatures. Amine 220 recently introduced, is effective at only 0.1 per cent.

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Historical Interest in Farm Mechanization

TO THE EDITOR:

RECENTLY Dr. Reynolds M. Wik flew in to see me between classes at the University of Minnesota. He received his PhD at Minnesota plus an award of $1500 from the Beveridge Fund of the American Historical Society. I believe this is the first time this award has been made on farm machinery history.

He spent two days with me going over the material I furnished from the West, and checking over my collection for material to add to his on steam engines in agriculture in the South.

Now is the time for a general stepping up of interest in farm equipment history. Dr. Wik says that he sees a big awakening among historians who have suddenly begun to realize that in writing the history of this country they have overlooked the one big thing that makes the United States the envy of the world today, namely, mechanization. He pointed out that no one has saved the "papers" of the 1500 auto builders, or of the manufacturers of farm equipment. Even the manufacturers themselves toss their old records into the bonfire every so often and never look back unless they reach the 100-year mark.

Why not put Dr. Wik on ASAE and other programs during the next year or so to spotlight this overlooked history of the United States? His book will cover only the steam side, but it should be interesting and dramatic as he tells how he pounded at the gates of the . . . Company for 19 days before he got into their vaults to unearth several boxes of letters written in the '60's and '70's. Not a one of the college agricultural engineering departments have dug out their own state histories on tractors.

Oakland, Calif. F. HAL HIGGINS

Engineering a First Need

To the Editor:

OUR fellow agricultural engineers interested in the over-all problem of conservation of the nation's soil resources may be encouraged by an editorial statement in the June, 1950, issue of *Land News*, a publication of the society known as Friends of the Land. Under the title "Robust Health and Soil," in answering the question "What can we do?", the editorial states:

> "First off, we can do our part to see that the proper engineering practices are applied to every acre of land in the United States."

A number of other needed measures to "hold this land" are subsequently listed. But it is most interesting to note that proper engineering practices were regarded as the first need. Agricultural engineers might question that engineering practices are a first need, any more than are other phases of the necessary integrated program, but they can take encouragement from the indication that there may be some respite in prospect from an era that has been characterized by a general lack of appreciation for the basic engineering aspects of our soil and water conservation problems.

R. B. HICKOK

Lafayette, Ind.

Cold Storage of Apples in Virginia

By Robert L. Givens
MEMBER A.S.A.E.

FOR many years proper control of air temperature was the only requirement for refrigerated apple storage. Today the condition of the apples entering the storage, quick removal of the initial heat, apple core temperature, storage atmosphere and relative humidity in the storage are recognized as important factors in the storage life of apples.

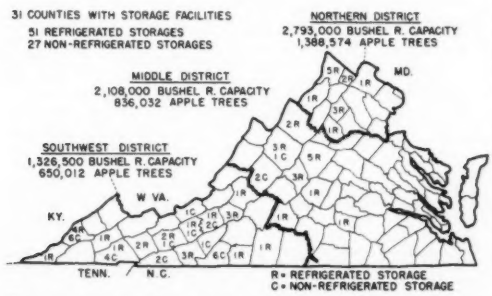
Many cold-storage plants, because of neglect in management, failure to operate at maximum efficiency, or inadequate buildings and equipment, are not utilized to the best advantage. As a result, much of the fruit is not handled properly nor cooled to the proper temperature for storage requirements. Apples are living organisms, both before and after harvest, and the length of time they may be held in storage depends upon how long their life process may be prolonged. It is important to remember that in most cases it is not known during the loading season how long the apples are to remain in storage.

During the early part of 1948, a project was undertaken by the Division of Farm Buildings and Rural Housing (BPISAE), U. S. Department of Agriculture, in cooperation with the Virginia Agricultural Experiment Station, for the improvement of the design and operation of cold storages for Virginia apples. As a basis for this project, a survey has been conducted to locate and collect certain engineering data pertaining to apple storages currently operated in Virginia. This survey has given an over-all picture of the existing equipment and practices.

Commercial apple growing in Virginia is in approximately 9 areas located on both sides of the Blue Ridge Mountains and extends from the extreme north to the extreme southwest. There are 78 storage plants in the apple-producing areas of Virginia as shown in Fig. 1. Of this number, 27 are common storages and 51 are refrigerated. These 51 refrigerated plants are composed of 27 privately owned, 20 commercial and 4 cooperative. In Virginia, there appears to be a trend toward the grower-owned-and-operated apple storage. Since 1938, there have been 22 grower-owned refrigerated plants constructed or converted from other uses. There is cold-storage space available in these 51 refrigerated plants, if fully occupied, sufficient to hold approximately 6,277,000 bu of packed fruit.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1949, as a contribution to the Farm Structures Division, and is a report of a study made under the Research and Marketing Act of 1946.

The author: ROBERT L. GIVENS, agricultural engineer, division of farm buildings and rural housing (BPISAE), U.S. Department of Agriculture (stationed at Blacksburg, Va.).



This map shows the location of 78 storage plants in the apple-producing areas of Virginia

These refrigerated plants, some of which were new construction and some converted from other uses, came into use between 1912 and 1948 and have a capacity range of from 1,000 to 1,500,000 bu each. Of these plants, 14 are cinder block, 8 are concrete, 7 are frame, 2 are stone, 6 hollow tile and 14 brick. Two of the refrigerated plants still use water power to run the compressors after the drawdown period.

A variety of insulating materials have been used in these refrigerated apple storage plants. It was found that 36 plants are insulated with block cork, 4 with rock wool, 1 with wood fiber, 7 with sawdust or shavings and 3 with granulated cork. In some cases, a combination of these materials have been installed. In 1947, a large refrigerated plant was constructed of double hollow tile blocks with no insulation being used. One season of use proved that this was a mistake and the owner has now installed 2 in of insulation on the outside walls; the roof and basement floor, however, remain uninsulated. Mistakes of this kind are not infrequent and usually cost more to correct than to use proper construction in the first place.

The most used refrigerant in the 51 apple storage plants has been ammonia. Forty-three plants use ammonia, 6 use freon, and 2 use methyl chloride. The freon and methyl-chloride plants have been installed since 1938. The two cooling systems being used are the blower type, with or without ducts, and the room-coil type. Thirty-five of the plants are cooled by room coils while sixteen are cooled by blowers. In a few of the room-coil-type plants, portable fans are used during the first month of storage to give additional air circulation. However, many of the owners of the blower-type cooling plants feel that the air circulation is sufficient regardless of the stacking arrangement in the room.

In Virginia, there are five methods of storing fruit in storages: the box (both the Northwest bushel and the Virginia bushel and one-eighth), the bushel basket, field crate, mesh bags, and bins. To conserve space, the boxes are usually stacked in a solid pile or a chimney stack, but a few operators allow about 2 in between every other row. Baskets are still used to a large extent in Virginia. Certain off grades are stored in field crates, mesh bags and bins, which are usually reserved for canner grades or in common storages. Apples are easily bruised, some varieties more than others, so that great care is required in handling to avoid bruising and skin punctures.

A typical summary of the refrigerated plants located in the northern district of Virginia is shown in Table 1. The following methods were used in estimating the capacities in the various plants.

Capacity The storage capacity of each cold storage room was computed from measurements taken at the plants. In all cases, the capacity indicated by the operator was not necessarily used in the computation but a standard equivalent of 3.5 cu ft per basket, and 2.7 cu ft per box was used which includes allowances for normal aisle space and stacking. The basket and box capacity was estimated by using figures from USDA Circular 740, table 7. In most cases, the computed capacity was very close to the estimate of the operator.

Building Loss. Records of the building construction and insulation were recorded on the survey form. For each type of construction, the conductance in Btu per square foot per degree per 24 hr was computed, using conductivity values found in the ASRE Data Book and the ASHVE Guide. The heat loss from walls was calculated using an outside temperature of 65 F and inside temperature of 32 F. From roofs the outside temperature was taken as 75 F and from floors on the ground 55 F was used. For floors off the ground or ceilings under shaded areas 65 F was used. In the calculations it was assumed that the insulation had retained its original condition. In general, the building losses reported are as low as may be expected and may be considerably too low

in some cases where the insulation has been broken or damaged.

Refrigeration Capacity. To compute the theoretical displacement of the compressors, the reported dimensions and speed were used. The actual displacement in these computations was assumed to be 80 per cent of the theoretical. The amount of refrigeration (gross) was estimated on the basis of the reported suction and discharge pressures during the fall. The net tons of refrigeration available for cooling fruit is the difference between the gross capacity of the machine and the sum of the building losses and other uses.

Storage Temperature. Records as to the aisle temperature reported by the operator do not indicate fruit temperatures which may be plus or minus due to location in the storage room or method of stacking.

SOUTHWEST DISTRICT

In this district, 22 of the 51 refrigerated plants are located varying in size from 1,000 to 375,000 bu. Storage space is available in this district for approximately 1,326,000 bu of packed fruit. The plants in this district average 2.4 stories with a total of 82 rooms. In a few cases, the second floor is used as a packing space which is characteristic of some of the small grower-owned plants.

The gross refrigerating capacity available in this district was calculated to be 1,189.2 tons. Building losses of 74.5 tons and icemaking of 487 tons in 7 plants leaves 627.7 tons available to cool apples. In this district, sixteen of the plants store baskets, four store boxes and baskets, and two store boxes only. Railroad sidings were found adjacent to six while sixteen rely on trucking facilities.

Storage temperatures as reported by the operators varied from 30 to 40 F. Only seven reported a temperature of 32 F or below while twelve reported a temperature of 33 to 36 F and three reported a temperature of 40 F.

MIDDLE DISTRICT

The Middle District has sixteen of the fifty-one refrigerated plants which vary in size from 5,000 to 375,000 bu. In this district, there is space available to store approximately 2,108,000 bu of packed fruit. These plants average 3.9 stories with a total of 89 rooms.

The gross refrigerating capacity available in this district was calculated to be 1,748.9 tons. Building losses of 155.8 tons and icemaking of 328 tons in 10 plants leaves 1,265.1 tons available to cool apples. Three of the plants in this area store baskets, eleven store boxes and baskets and two store boxes only. Railroad sidings were found adjacent to eleven while five rely on trucks.

Storage temperatures as reported by the operators varied from 31 to 34 F. Twelve of the operators reported a temperature of 32 F or below while four reported a temperature of 33 to 34 F.

NORTHERN DISTRICT

Thirteen of the 51 refrigerated plants, varing in size from 28,000 to 1,500,000 bu are located in this district. Space is available to store approximately 2,793,000 bu of packed fruit. With an average height of 3.2 stories these plants have a total of 66 rooms.

The gross refrigerating capacity available was calculated to be 1,368 tons. Building losses of 113.5 tons and icemaking of 129.5 tons in 4 plants leaves 1,125 tons available to cool apples. One of the plants stores baskets, eight store boxes and baskets, and four store boxes only. Railroad sidings were found adjacent to six while seven are served by trucks.

Storage temperatures as reported by the operators varied from 31 to 33 F. Twelve of the operators reported a storage temperature of 31 to 32 F while only one reported a temperature of 33 F.

DISSUSSION

After making allowances for heat losses through the structures, motor losses and incidental losses, the refrigeration equipment in the 51 plants has a total value of approximately 3,000 net tons available for cooling fruit. However, in one plant, only one-half of the refrigerating capacity is used during the loading period. In this case, there are two 4-cylinder 3½x3½-in compressors rated at approximately 17 tons. During the loading period, only 1 compressor is used delivering about 8.5 tons when the normal loading for this plant requires about 15 tons. It is believed that failure of some plants to operate at capacity may reduce the 3,000 net tons of refrigeration to about 2,500 tons. This indicates that during a 14-day harvesting period the average daily picking of apples could be properly cooled. However, on peak days the loading may be greater than the daily average, due to storing in the packing house for as much as 5 to 6 days before packing is started in full force.

Pallet handling has not reached the point of being a problem in the existing storages in Virginia. Only one plant has been built with this method of loading incorporated in the design. One other plant uses a fork-lift truck to convey boxes or baskets from the packing house; the baskets are restacked in the storage but the boxes remain on the pallets. However, as high labor costs continue or increase, the storages constructed in the future will most likely be designed around the forklift truck and pallet.

The storage season in Virginia varies with the location as well as the varieties grown. September 1 to 15 is the usual starting period and most of the loading has been completed by November 1. The length of the storage period is governed somewhat by the market conditions or the condition of the fruit and will extend to January 1, or in some cases as late as June 1. Most of the operators prefer to end the storage period during March or April.

Air purification in apple cold storages has been a subject of much discussion among fruit growers in Virginia for the past 2 or 3 years. The purification is done by passing air over activated charcoal. The Virginia Agricultural Experiment Station has begun a series of physiological studies on Virginia-grown apples and it is understood that air purification is to be included. In the past two years several plants have installed commercial air-purification units. One manager has constructed and installed, according to his own design, four air-purification units in as many rooms. The data currently available do not seem to warrant definite conclusions as to the effectiveness of purification equipment in apple storages other *(Continued on page 165)*

TABLE 1

Typical Summary of Refrigerated Apple Storage Plants

Northern District

Storage Unit	Capacity (bushels)	No. Stories	No. Rooms	Refrigeration - Tons				Type Container	Railroad Siding	Storage Temp. °F.
				Gross	Bldg. Loss	Other Uses	Net			
A	60,000	1	2	15.3	2.0	-	13.3	Box & Basket	No	32°
B	60,000	3	7	14.3	1.1	-	13.2	Box & Basket	No	32°
C	150,000	3	6	44.5	11.0	-	33.5	Box & Basket	No	32°
D	175,000	6	6	375.0	7.8	Ice 75	292.2	Box & Basket	Yes	33°
E	330,000	6	6	182.0	14.2	Ice 15	152.8	asket	Yes	32°
F	1,500,000	7	19	427.0	37.2	Ice 25	364.8	Box & Basket	Yes	31°
G	170,000	5	5	135.0	10.6	Ice 14.5	109.9	Box	Yes	32°
H	28,000	2	3	11.2	3.5	-	7.7	Box & Basket	Yes	32°
I	100,000	2	1	39.2	14.2	-	24.4	Field Lugs	Yes	31°
J	63,000	2	5	27.8	2.3	-	25.5	Box & Basket	No	32°
K	35,000	1	2	23.4	1.3	-	22.1	Box	No	32°
L	38,000	2	2	18.9	3.9	-	15.0	Box	No	31°
M	84,000	2	2	54.4	3.8	-	50.6	Box & Basket	No	32°

Supplemental Irrigation of Pasture

By R. W. Whitaker and W. F. Lytle
JUNIOR MEMBER A.S.A.E. MEMBER A.S.A.E.

SUPPLEMENTAL irrigation of ladino clover-grass pasture was studied at the University of Illinois Dixon Springs Experiment Station in southern Illinois during the 1948 and 1949 seasons. The work was carried out cooperatively by the University of Illinois, the Soil Conservation Service (Research), and irrigation equipment manufacturers and distributors.*

Very little information has been available concerning supplemental irrigation of pastures in the Midwest. It is generally known that the summer droughts, particularly during July and August, may seriously reduce pasture productivity. Drought conditions, in so far as optimum growth and production are concerned, may occur even though the year is not regarded as being a drought year. Pasture growth and subsequent animal gains or production may practically cease during the hot dry weeks of the summer. In some instances the pasture is damaged so that new growth does not occur with subsequent rains. As a result pasture systems of farming are uncertain.

The objectives of the experiment were to study (a) amount and frequency of water application, (b) fertilizer treatment giving best results with irrigation, (c) effect of irrigation on available soil moisture, and (d) increase in plant growth and animal gains on irrigated as compared to unirrigated pastures. Labor and operating costs were also recorded although the acreage studied is considered too small for establishing reliable per acre costs of pasture irrigation. However, the information obtained during the past two years provided a basis for estimating the gross and net gains to be expected from full-scale supplemental irrigation of pasture in southern Illinois.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1949, as a contribution of the Soil and Water Division.

The authors: R. W. WHITAKER and W. F. LYTLE, respectively, special research assistant and instructor in agricultural engineering, University of Illinois, Urbana.

*The pasture irrigation project was initiated and administered jointly by the Dixon Springs Experiment Station, the department of agricultural engineering, University of Illinois, and the U.S. Soil Conservation Service (Research). The field work was supervised by G. E. McKibben, first assistant in agricultural research and extension, and R. J. Webb, superintendent of the Dixon station. L. E. Gard, formerly with the Soil Conservation Service, supervised the soil-moisture determinations. Equipment was loaned by John Effa, equipment engineers, Chicago, Ill., and funds were provided by the Aluminum Co. of America.

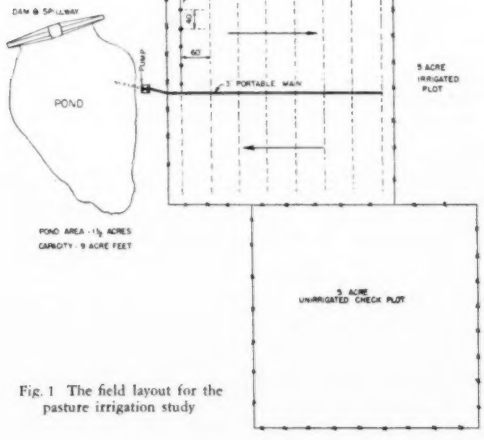


Fig. 1 The field layout for the pasture irrigation study

Fig. 1 shows the field layout for the pasture irrigation study. Irrigation water is pumped from a 1½-acre pond adjacent to the fields. The capacity of the pond is about 9 acre-feet when filled to spillway level.

The equipment consisted of quick-coupling portable aluminum pipe, rotating sprinklers, and a gasoline-engine pump unit capable of delivering 3600 gph at 40 psi pressure. This portable-type equipment is well adapted for supplemental irrigation in Illinois. The main line is 3 in diameter and the lateral line 2 in diameter. Six rotating sprinklers are spaced at 40-ft intervals along the lateral. Each sprinkler applied 8 gpm at 40 psi operating pressure. This rate of application is about ⅓ iph, or 1 in every 3 hr.

Due to the experimental nature of the study only 5 acres are being irrigated. Larger acreages would ordinarily be irrigated for practical conditions in Illinois. A 5-acre unirrigated field similar in slope, fertility, soil type and treatment adjoined the irrigated field and is used as a standard for measuring results.

The soil is a gray-brown silt loam with a reddish-yellow silt subsoil and a compact very slowly permeable silty-clay-loam substrata. This soil type is found extensively in southern Illinois. Both fields were fertilized with 3 tons of lime and 1000 lb of rock phosphate per acre in the fall of 1947. Further fertilizer treatment was added in 1948 and 1949 as indicated in Table 1.

TABLE 1. VARIOUS FERTILIZER TREATMENTS STUDIED ON IRRIGATED AND UNIRRIGATED FIELDS

Plot Number	1948	1949
1	500 lb superphosphate (20%) 500 lb potash (50%)	None
2	500 lb superphosphate (20%) 500 lb potash (50%) 600 lb ammonium sulphate*	370 lb ammonium sulphate*
3	500 lb potash (50%) 600 lb ammonium sulphate*	370 lb ammonium sulphate*
4	None	None†

*Ammonium sulphate was applied at intervals during the growing season. Total applications are shown above.

†In 1949 plot No. 4 was subdivided into four ½-acre plots. Three of these plots received additional treatments. Since very little effect was noted for the 1949 season these treatments are not shown.

The fields were seeded with a mixture of ladino clover, bluegrass, redtop, timothy, fescue, and orchard grass in the fall of 1947 and the spring of 1948.

Soil Moisture. The effect of supplemental irrigation in maintaining usable soil moisture is shown graphically in Fig. 2 and 3 for the 1948 and 1949 seasons, respectively. The occurrence and amounts of natural rainfall and of irrigation water are also shown by the bar graphs at the lower portion of the charts.

In order to determine the effectiveness of various amounts of irrigation water the irrigated field was divided for the 1948 season one-half receiving six 1-in applications and the other half six 2-in applications. Results indicated that 2-in applications were more economical and gave greater returns per acre-inch; therefore, only 2-in applications were used in 1949.

The per cent usable soil moistures were determined by the plaster of paris moisture block, electrical resistance method developed by Dr. Bouyoucos at Michigan State College. Usable soil moisture is defined as that moisture in the soil which is available for plant use. One group of blocks were located at 3, 9, and 18-in depths and another group at 1½, 4½, 7½, 10½, 15, 21 and 36-in depths. The electrical resistance was measured periodically at each block and converted to per cent

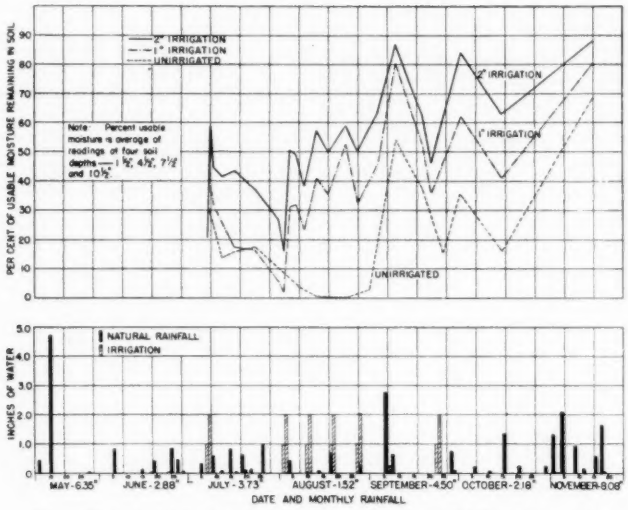


Fig. 2 Effect of rainfall and irrigation on usable soil moisture (1948 grazing season)

usable soil moisture by use of a calibration curve for the given soil type.

A recent moisture meter developed by Dr. Bouyoucos gives a direct reading of the per cent usable moisture remaining in the soil.

The moisture curves on Figs. 2 and 3 are averages of the per cent usable soil moisture remaining at the 1½, 4½, 7½ and 10½-in depths. Readings taken at the 4½-in depth were found to agree very closely with the averages mentioned above.

In 1948, the usable soil moisture decreased rapidly during July. A prolonged dry period during the latter half of May and all of June had reduced the soil moisture to a low level. The first irrigation, July 7, raised that usable soil moisture percentage temporarily, then it continued to drop during the remainder of July although several natural rains occurred. Successive irrigations were required every week during August to raise the usable moisture to 35 per cent on the field receiving 1-in applications and to 50 per cent on the field receiving 2-in applications. During this same period only 0 to 5 per cent usable moisture remained in the soil on the unirrigated field. Growth was practically dormant during this period on the unirrigated field and some of the plants died.

The 1949 season was considered good from the standpoint of natural rainfall. A comparison of the number of days in each season during which 2 in of rainfall had not occurred for a period of two weeks shows 126 such days for 1948 and 85 for 1949. This comparison shows the effect of natural rainfall occurrence on the frequency that irrigation will be required.

In 1949, as shown by Fig. 3, the per cent usable moisture available on the irrigated field several times dropped below that on the unirrigated field. The more rapid decrease on the irrigated field is attributed to the greater moisture demands of the heavier vegetative growth on the irrigated as compared to the unirrigated field.

Pasture Yields. Pasture yields from the irrigated and unirrigated fields are shown in Table 2. Yields were measured for four different fertilizer treatments (Table 1). The yields shown are for 2-in applications of water—six applications for a total of 12 in in 1948 and three applications for a total of 6 in on the south plots in 1949 and four applications for a total of 8 in on the north plots. Before comparing the yields it should be noted that the yields were determined for the grazing season only. In 1948 the pasture was grazed from July 20 until November 8 (111 days) and in 1949 from April 26 to October 12 (169 days). Lighter first-year growth plus a shorter grazing season accounted for part of the differences in yields between 1948 and 1949.

Irrigation increased production for all soil treatments. The largest gains from irrigation were for fertilizer treatment No. 1 which consisted of superphosphate and potash applied in addition to the basic lime and rock-phosphate treatment applied before seeding. Fertilizer treatment No. 2 was the same as No. 1 plus nitrogen applied during the growing season. The slight gain in total production (Table 2) does not appear profitable for irrigated legume pastures.

TABLE 2. YIELD IN POUNDS DRY MATTER PER ACRE ON IRRIGATED AND UNIRRIGATED PLOTS — 1948 AND 1949 GRAZING SEASONS*

	Fertilizer treatment	Unirrigated	Irrigated	Pounds dry matter per acre gain from irrigation	Per cent increase
1948	1	3668	7334	3666	100
	2	4846	7639	2793	58
	3	4039	6359	2320	58
	4	2618	4187	1569	60
1949	1	7643	11696	4053	53
	2	10553	11992	1439	14
	3	8548	10612	2064	24
	4	4908	7161	2253	46

*1948 grazing season, July 20 to November 8—111 days
1949 grazing season, April 26 to October 12—169 days

The yields for various fertilizer treatments show the importance of applying fertilizers in the proper balance and

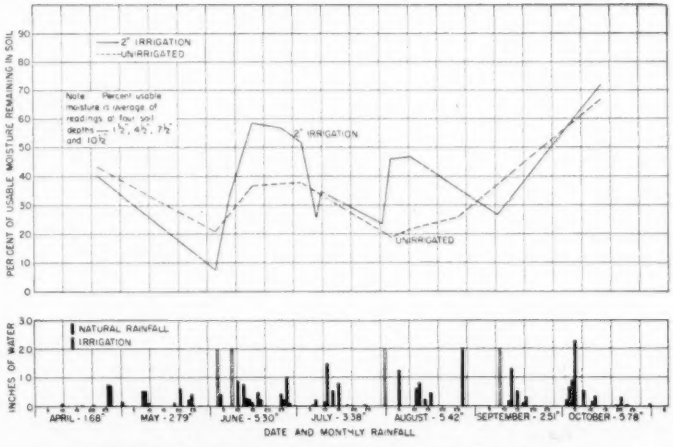

2" IRRIGATION
UNIRRIGATED
PER CENT OF USABLE MOISTURE REMAINING IN SOIL
Note Percent usable moisture is average of readings at four soil depths — 1½", 4½", 7½" and 10½"
NATURAL RAINFALL
IRRIGATION
INCHES OF WATER
APRIL - 1.68"
MAY - 2.79"
JUNE - 5.30"
JULY - 3.38"
AUGUST - 5.42"
SEPTEMBER - 2.51"
OCTOBER - 5.78"
DATE AND MONTHLY RAINFALL

Fig. 3 Effect of rainfall and irrigation on usable soil moisture (1949 grazing season)

quantities for irrigated pastures. Otherwise lack of soil nutrients may limit forage production even though adequate water is available.

The study indicates that pasture life may be extended by irrigation; a significant advantage for legumes such as ladino clover which are very expensive to seed. Regardless of treatment, the per cent of ladino clover was always greater on the irrigated plots. The comparisons were based on point-quadrant counts of vegetative growth.

Animal Gains. The pastures were grazed with sheep in 1948 and with sheep and a few cattle in 1949. Sheep were used in preference to cattle primarily because a larger number of animals could be pastured. Variation in the growth of an individual animal gives less error when averages are considered. Ewe lambs from the spring crop were used.

Returns were measured in terms of pounds gained by the animals while on the pasture. The animals were weighed before turning out to pasture and again when removed from the pasture. Since the carrying capacities of the fields were unknown it was necessary to estimate the number of animals to place in each field. Both irrigated and unirrigated fields were pastured the same number of days. Animals were removed when necessary to give comparable grazing on both irrigated and unirrigated fields. In 1948 the irrigated field carried an average of 5.7 animals per acre as compared to 2.4 on the unirrigated field.

TABLE 3. COMPARISON OF ANIMAL GAINS AND GROSS RETURN PER ACRE ON IRRIGATED AND UNIRRIGATED PLOTS IN 1948 AND 1949*

	1948		1949	
	Unirrigated	Irrigated	Unirrigated	Irrigated
Total gain, lb	270	700	1955	2665
Gain, lb per acre	54	140	391	533
Gross return per acre†	$13.50	$35.00	$97.75	$133.25

†Based on 25 cents per pound of animal gain

*1948, 111 days; 1949, grazed 169 days

The results in terms of animal gains and gross returns per acre for the 1948 and 1949 seasons are shown in Table 3. In 1948, the gain per acre on the irrigated field was 2.6 times the gain on the unirrigated or an increase of 159 per cent due to irrigation. In 1949 the gain on the irrigated field was 1.4 times the gain on the unirrigated or an increase of 36 per cent. The 1949 season was considered very good from the standpoint of natural rainfall. The total gains in 1949 were much higher than in 1948 because of a longer grazing season, heavier second year pasture growth, and more abundant natural rainfall. Gross returns per acre based on 25c per lb of animal gain are also shown in Table 3. The gross increase due to irrigation amounted to $21.50 per acre in 1948 and $35.50 per acre in 1949.

The total cost of irrigating was approximately $3.83 per acre-inch for six 2-in applications. Labor made up about 20 per cent of the total cost with fuel, repairs and fixed cost (depreciation and interest) accounting for the remaining 80 per cent. About one man-hour of labor was required per acre-inch for 2-in applications. The cost per acre-inch will increase for less frequent applications because the fixed costs remain the same regardless of frequency of application.

CONCLUSIONS

Results from this study show that pasture yields and hence animal gains on southern Illinois pastures may be increased by supplemental irrigation. In 1948, a season of poor rainfall distribution, yields were increased as much as 100 per cent by irrigation. Results from the 1949 season, a good season from the standpoint of natural rainfall, showed yield increases as high as 53 per cent. Years of above average rainfall may have drought periods of sufficient length so that supplemental irrigation will also give significant increases in yields.

Two-inch applications were more economical than one-inch applications for the particular situation studied.

Irrigation water should be applied whenever the usable moisture remaining in the soil drops to 35 per cent and for maximum production this value may be higher — possibly 50 per cent.

For the soil type studied moisture measurements taken at one depth from 4½ to 6 in deep will agree closely with the average of measurements taken at 1½, 4½, 7½ and 10½-in depths.

Results from this study indicate that at least 2 in of water (natural rainfall or irrigation) are required during each 2-week period to maintain abundant plant growth.

A comparison of the second year growth on the irrigated and unirrigated fields shows that irrigation will extend the life of legume pastures.

Proper fertilizer treatment is necessary if full benefits are to be realized from supplemental irrigation.

Cold Storage of Apples

(Continued from page 162)

than that if properly used odors can be eliminated.

During the fall and winter of 1948-49 temperatures were recorded in one of the grower-owned-and-operated refrigerated plants. This plant has 2 rooms, approximately 17,500 bu capacity each, identical in size and arrangement with a cooling unit located in the center of each. One room remained as built, the other room was modified by the addition of ducts to incorporate a system of reversed air flow. In the unmodified room the top basket of a stack of eight high, in the direct blast of the supply air, cooled to 31 F in 4.5 days while another basket in a back corner at the bottom required 91 days to be cooled to 32 F with the supply air temperature averaging about 28.1 F. This season's records are following somewhat the same pattern. After the drawdown period, the average temperature variation in the room was 4.2 F.

The modified room for the first season of operation was not as satisfactory as was expected. A basket of fruit in this room located on the top of the pile and receiving the direct blast of supply air cooled to 31 F in 13 days when the supply air temperature averaged about 28.3 F. The warmer fruit was found in the center of this room during both the drawdown and holding periods. After the drawdown period, the average fruit temperature variation was 3.0 F as compared to 4.2 F in the unmodified room. With a few adjustments on the dampers and duct outlets since last season and using a lower supply-air temperature in this modified room, the cooling rate and fruit temperatures are much more satisfactory this season.

Off grades and canner apples are stacked in field crates in most of the storages in Virginia. The crates are usually placed side by side and a block of fruit may be 10 high and as much as 10 wide; in other words, a solid mass of fruit. Temperature records on this method of stacking crates were kept during this season. Apples in the top crate (10 high) cooled to 33 F and the bottom crate to 40 F over a 3-weeks period; after 6 weeks the top crate was 30.4 F and the bottom crate was 39.6 F. Off grades and canner apples usually remain in storage a short period although some are on hand as late as January 1.

CONCLUSIONS

In talking with many owners and operators of apple storage plants in Virginia, many problems have been brought to light. Observations around the orchards, in the packing houses, and in the storages indicate that the owners do not realize that many problems exist. With proper management, the situation could be greatly improved. In most cases, the owners do not take time to study the situation or observe the workman during the harvest period to see just how the job is being done. Regardless of the origin of the troubles, the blame is usually placed on the storage, which reflects on the whole industry.

Minimum Requirements for the Design, Installation and Performance of Sprinkler Irrigation Equipment

PROPOSED ASAE RECOMMENDATIONS

(NOTE TO ASAE members: These proposed ASAE-sponsored recommendations were initiated in 1948 by the ASAE Subcommittee on Sprinkler Irrigation, a subcommittee of the Committee on Irrigation of the Soil and Water Division, the personnel of which is comprised of agricultural engineers recognized as authorities in the field of sprinkler irrigation, in the employ of state and federal agencies and of related industry. These recommendations have been the subject of painstaking study by the Subcommittee and, in addition to receiving its formal approval, they have also received the official endorsement of the Association of Sprinkler Irrigation Equipment Manufacturers. Excerpts from a letter dated January 9, 1951, from ASIEM President Crawford Reid to that effect follow:

"... Regarding the minimum requirements on sprinkler irrigation, as approved at the Chicago 1950 ASAE meeting, will say that I agree that many responsible individuals representing member companies of the Association of Sprinkler Irrigation Equipment Manufacturers approved these requirements at the Phoenix Convention Meeting held on November 11, 1950.

"In addition to this, the final subcommittee of 10 was composed of 7 in industry, the other 3 members being Mr. Molenaar, Mr. Swarner and Mr. Peikert. Also, the minimum requirements were studied by the Subcommittee in a general meeting of many members of industry, at various sectional meetings of the ASAE from time to time. I think that the industry is quite in accord with these minimum requirements, and urge that they be published so that they may be quoted and republished by industry for the good of all farmers who expect to purchase irrigation systems."

The proposed ASAE recommendations are published here to give ASAE members an opportunity to study and become familiar with them, before being asked to vote on their official adoption by the Society. A letter ballot will go forward to the members in due course. —Raymond Olney, Secretary, ASAE.)

THESE minimum requirements pertain to the design, installation, and performance of sprinkler irrigation equipment, and include dealer-purchaser responsibilities. The design and performance requirements are concerned particularly with those factors that are directly related to land, crops, and farm operations. The dealer-purchaser responsibilities recognize successful operation of a sprinkler system as depending on both buyer and seller.

PART I. DESIGN AND PERFORMANCE

1 Application Rate. A portable sprinkler irrigation system, when properly designed and operated, shall meet the following conditions with respect to water application:

(a) Apply water at a rate which does not cause runoff during the normal operating period nor cause water to stand on the surface of the ground after the sprinkler line is shut off.

(b) Determination of the proper rate of application *shall be the responsibility of the person designing the system.* Values for bare ground infiltration rates for different types of local soils may be obtained from responsible agricultural technicians. In the absence of such technical advice, the designer may estimate the proper application rate on the basis of past experience with similar soil types.

2 System Capacity.

(a) For regularly irrigated areas, the system shall have the capacity to meet the peak moisture demands of each and all crops irrigated within the area for which it is designed. Sufficient time must be allowed for moving laterals and for permitting cultural practices on the land. The capacity must also allow for reasonable water losses during application periods with the system operating in accord with design conditions.

(b) For supplemental irrigation and/or special uses, the system shall have the capacity to apply stated amount of water to the design area in a specified net operating period.

3 Depth of Water Application. In the design of the system, total depth of application (equivalent rainfall) per irrigation shall be governed by the capacity of the soil for moisture storage and the depth of the principal root zone of the crop irrigated. Information on both of these factors may be obtained from agricultural technicians or may be estimated by the designer on the basis of his past experience with similar soil types and crops.

4 Uniformity of Water Application. Since uniformity of water application is affected by both pressure in the line and spacing of sprinklers, recommendations for desirable operating pressures and spacings for different types of sprinklers and nozzle sizes shall be obtained from the sprinkler manufacturer.

Differences in pressures at the sprinklers shall be kept to a minimum to assure reasonably uniform distribution of water over the entire design area. A common rule, *which should be adhered to as closely as practicable,* is to limit pressure differences along a sprinkler lateral to 20 per cent of the higher pressure.

Excessive pressure differences in the main or supply line result in widely varying pressures at the head of the laterals. In many instances these excessive variations cannot be controlled by pipe size alone. Then the only practical alternative is to design for adequate pressure at the lateral take-off where pressure in the main will be lowest, and instruct the operator in regulating pressures into the other laterals by adjusting the take-off valve openings.

5 Crop Damage. Water shall be applied in a manner which will not cause direct physical damage to plants or fruit.

PART II. DEALER-PURCHASER RESPONSIBILITIES

A. Dealer Responsibility

1 Proper Design. When the system is planned by a dealer, or his representative, the dealer shall assume full responsibility for the proper design of the system he proposes to furnish. Design requirements to fit the system to conditions of soil, topography, water supply and crop enterprise shall be ascertained by the dealer either directly or by obtaining such information from recognized reliable sources.

When design requirements are furnished in writing by the purchaser, the dealer's responsibility shall be limited to the design of the system to meet the stated conditions.

When plans and specifications are furnished in writing by the purchaser, the dealer's responsibility shall be limited to supplying equipment which will satisfy the requirements of the specifications furnished.

When the purchaser buys the system piecemeal, he absolves all dealers of responsibility for the performance of the system as a unit.

2 Proper Installation. The dealer or his representative shall assume full responsibility for the proper installation of the system.

Pumps and power units shall be set on a firm base and care shall be taken to keep the pump and the motor or engine in proper alignment.

Wiring and starting equipment for electrically operated plants shall comply with approved standards. Electric motors shall be provided with overload and low-voltage protection.

Internal-combustion engines shall be provided with protective devices. Thermostats shall be supplied that stop the engine when water or oil temperatures exceed the safety point. Where conditions are such that a failure of the water supply might result in the pump losing its prime, the pumping plant shall be protected by a device that stops the engine. These devices may be dispensed with where conditions are such that there is little probability of water supply failure, or when the pumping plant is constantly attended. *(Continued on page 168)*

Auger Types for Farm Machines

By E. A. Wendell

THE auger or so-called conveyor screw as used in farm machines comprises one of the largest groups of applications in any one industry, and for many years has been a familiar piece of equipment on almost every farm.

Although the conveyor-screw principle was discovered by Archimedes many years ago, it has taken the combined efforts, ingenuity and resourcefulness of the farm machinery manufacturers, the research and engineering departments of many universities, and those skilled in the art of design and manufacture of screw conveyors, to bring about improvements in design and application, all of which has led to increased production and lower costs.

In its mechanical application to the carrying of material, the screw conveyor has, like the farm machinery on which it is used, taken some 75 years to come from its first crude form to the present up-to-date line of equipment.

In 1874, H. W. Caldwell devoted himself to the improvement of spiral conveyors. The devices in use up to that time were extremely crude and unsatisfactory, yet served in a measure for the purpose intended. The first work undertaken by Mr. Caldwell was the improvement of the sectional flight.

Conveyors up to then were made of cast iron, hammered tin or crudely formed iron flights on wooden or solid shafts. The common form of flour-mill conveyor consisted of wooden pegs or paddles inserted spirally into an octagon or hexagon wooden shaft. This unit moved material forward very slowly.

The next step in the improvement of the screw conveyor was the invention of the helicoid or continuous-flight-type conveyor screw, which Mr. Caldwell patented in 1898. It was during this period that the screw conveyor was first introduced as a part for farm machinery. It can well be imagined that in those early stages both the helicoid and sectional conveyor were still crude pieces of equipment.

An example of progress, in the early days of the combine, was the improvement of the auger for picking up the grain back of the sickle bar. Originally it was made of screw flights mounted on about 2 to 3-in-diameter pipe, but the straw wound around this small diameter shaft and was difficult to remove. Research over a long time proved that a larger diameter tube would considerably reduce the difficulty and today the screw flight is mounted on steel tubes of 6-in diameter and larger.

As farm machines were improved in design and many units added for more applications, the screw conveyor kept pace with these developments, until today in its modern form it has become a prominent component in farm machinery.

To enumerate all the farm machines on the market today that employ augers, and the respective function of each, would require too much space to include in this paper which will be confined to a general discussion of the application of augers in farm machines.

Augers are comparatively simple in design, are efficient and economical, and consist of only one moving part made up of several components. They are compact, requiring little space, with no idle return. The screw conveyor is versatile and, designed for its specific application, it conveys, elevates, digs, mixes, or spreads.

For the benefit of those who may not be familiar with the construction of augers, there are basically two types, namely, the helicoid or continuous-flight type and the sectional-flight type.

The helicoid, or spirally curved, continuous-flight type is manufactured by feeding a steel coil strip of required gage and width into a specially designed rolling mill. The resultant product is a continuous helicoid flight of a desired diameter and pitch with a center hole for mounting on a tube, pipe or shaft (Figs. 1 and 2).

The sectional-flight type is manufactured by blanking or burning pierced center-hole disks of proper diameter for a desired conveyor screw from steel sheet or plate of desired gage. The disk is then split or cut radially from the center hole and formed into a spiral (Fig. 4). These spirals are lap-riveted, lap-welded or butt-welded into a fabricated flight of desired length, for mounting on a tube, pipe or shaft (Fig. 3). The auger is then fitted with tail and drive ends for bearing supports and for mounting the sprocket, sheave or gear for driving it.

Both helicoid and sectional-flight-type conveyor screws are made in a wide range of diameters, pitches and gages. In addition to the basic solid-flight-type conveyor screws, there are for specific applications of conveying, mixing, etc., the continuous-flight or sectional-flight ribbon type, the cut and folded flight, the paddle type and the combined screw and paddle type. Screw conveyors in certain diameters and for specific applications are also made of cast iron. Conveyor screws, in addition to being made of black steel, can also be made of stainless steel or any one of a number of metals that may be required for certain applications.

Where a screw conveyor can be successfully employed for applications of conveying, elevating and mixing, there is a type and size of auger applicable to the particular requirement.

On the modern combine, as an auger for gathering the cut grain back of the sickle bar and delivering it to the pick-up conveyor, the conveyor screw has become practically standard equipment. Helicoid continuously rolled flighting or sectional-flight type is welded to steel tube of desired diameter

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1950, as a contribution of the Power and Machinery Division.

The author: E. A. WENDELL, sales manager, Caldwell Plant, Link-Belt Co., Chicago, Ill.

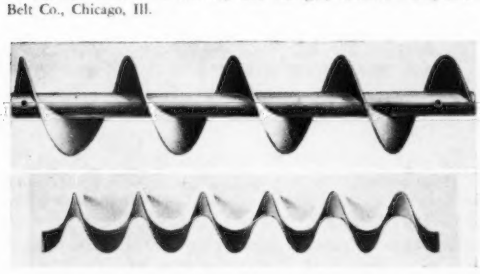


Fig. 1 *(Top)* Helicoid-flight conveyor screw
Fig. 2 *(Bottom)* Helicoid conveyor flight

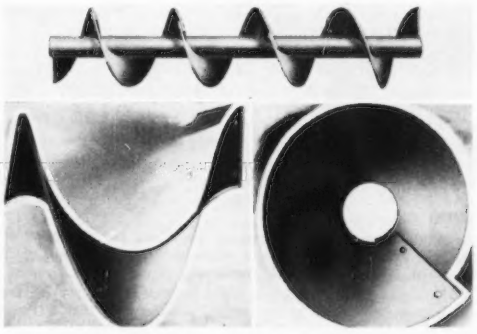


Fig. 3 *(Top)* Sectional-flight conveyor screw
Fig. 4 *(Bottom)* Sectional conveyor flight

to form an efficient unit of the single or double type. Overhung single screws, or two screws right and left hand with open center, or a single screw right and left hand with center beater or saw-tooth blade, or with the projecting and retracting fingers in the center section, are the various types used on combines on the market today. These augers are often referred to as platform, table and header augers.

Internally in the combine, augers are also used for conveying the tailings and grain. The unloaders from the grain tanks on the combine also employ augers operating in steel tubes for rapid unloading.

For contour plowing or terracing, augers play a prominent part on some of the implements used for this work.

The posthole digger is becoming a more popular machine for building and maintaining farm fences, and for this purpose conveyor screws are employed in the form of flighting welded to steel pipe, to provide a unit without joints or seams to remove the earth smoothly and cleanly.

Some types of barn cleaners employ conveyor screws operating in a concrete trough adjacent to the stalls, to convey the waste to the outside for disposal. The equipment is easy to clean and is always ready for use.

On many makes of manure spreaders, the conveyor screw, located behind the beater teeth, is used to obtain a wide spread and to assure uniform spreading.

The more or less conventional trench digger used in excavating for drainage or irrigation employs a chain with digger bits to bring the earth to ground level, and on these machines conveyor screws are sometimes used to deposit the earth on each side of the trench.

Conveyor screws are used in some hay balers for delivering hay to the open bale chamber gently, firmly and with positive feed.

Another application where conveyor screws are commonly used is in connection with ensilage blowers, insuring positive and uniform movement of material to the blower, for elevating chopped hay into the mow, ensilage into the silo, or grain into the granary.

Feed grinders employ conveyor screws on the blower shaft to convey the feed to the blowers, and many of these grinders also use conveyor screws operating in a tube to elevate the ground feed to bins, wagons or trucks.

Some forage harvesters employ conveyor screws to feed material to the cutters.

Hay and alfalfa drying is another operation, in connection with which the screw conveyor is often used.

Some of the corn pickers on the market today use conveyor screws for assuring positive delivery of corn from hopper to husking unit.

Another very extensive use of augers is in grain loading and unloading, to and from wagons, trucks, and bins. Most of this equipment is of the portable type and the conveyor screw usually operates in a tube or pipe for handling material on the horizontal, incline or vertical.

Soil tillers which may serve as a plow, disk, or harrow, are another example of the use of the popular auger.

In the rice fields, where combines are used, we have the rice carts or buggies which are commonly used for transporting the rice over soft ground by tractor haul to trucks on a hard road. On many of these carts or buggies the familiar auger operates in tubular casings for elevating the rice from the bottom outlet of the cart or buggy to the truck.

On a cotton harvester a right- and left-hand screw conveyor forwards the material in an alternate flow from the rear end of each cleaning chamber to a centrally located inclined rear elevator.

Aside from the uses for grain, soybeans, rice, and cotton, we find extensive use of screw conveyors in the processing of these products in flour mills, extraction plants, cotton gins, etc.

In these days when demands are ever increasing for greater production at lower costs, there is need for still further mechanization of more operations on the farm, and the screw conveyor will continue to make its contribution toward advancing this development.

Requirements for Sprinkler Irrigation

(Continued from page 166)

3 Operating Instructions. The dealer or dealers furnishing equipment required for a complete sprinkler system shall furnish to the purchaser, in writing, such instructions, performance charts and layout drawings as are required to insure proper operation, in accord with design conditions and normal expected life for the type of equipment furnished.

4 Performance Warranty. When a dealer or associated group of dealers assumes responsibility for the design and installation of a sprinkler irrigation system, a warranty shall be furnished, stating specially the performance expected for water-application rate, capacity, rate of coverage for a specific design area serving specific crops and crop acreages as stated by the purchaser and mutually understood to be the basis of design.

Warranty shall be based on trial of the system during operation under the range of operating conditions imposed on the system. The warranty shall not be expected to cover any conditions encountered which were beyond reasonable control of the dealer either in design or installation. Values used for infiltration rate, peak-use rate of moisture by crops, or capacity of soils to retain water for plants cannot be expected to be accurate for every local condition of soil. Evidence that the dealer has made reasonable efforts to obtain values from reliable sources shall be sufficient reason to absolve him from responsibility if such values do not represent local conditions.

When a dealer or dealers assume responsibility for the installation of a system in accord with specifications supplied by the purchaser, a warranty shall be furnished, stating the performance expected as to friction loss in the system, pump and engine motor characteristics, and other pertinent data pertaining to the specifications.

5 Equipment Warranty. The dealer or dealers assuming responsibility for the installation of the system shall furnish warranties covering the quality of material and workmanship of each piece of equipment furnished in accord with the original manufacturer's guarantee, and shall provide for replacement of defective parts shown to have failed because of poor quality materials or poor workmanship.

6 Maintenance and Repair Service. Dealers selling sprinkler irrigation systems in a territory shall maintain an inventory of replaceable parts and required equipment repair service. The extent of this available service shall be such that users in the territory will be assured of reasonable service which will avoid crop loss due to shutdown of a system for replacements or repairs.

B. Purchaser Responsibility

1 Operations in Accord with Instructions. The purchaser and user of a sprinkler irrigation system shall assume responsibility for failure of the system to perform properly if, after receiving all data furnished by the dealer, he fails to operate the system in accord with all conditions assumed in the design of the system. To obtain the full life of all equipment the user shall observe the stated limits of operating conditions set forth by the manufacturer.

2 Care and Maintenance Recommendations. The purchaser shall follow the dealer's recommendations for care and maintenance of the equipment. This applies to periods of use as well as non-use of the equipment.

PART III. DEFINITIONS

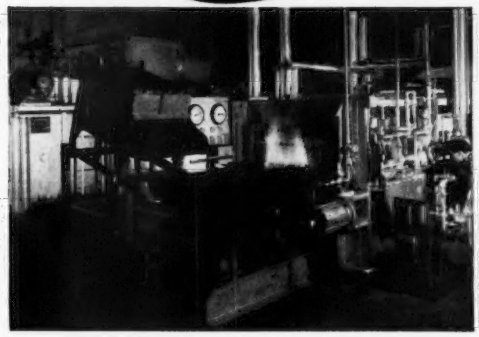
Design Area. The specific land area which the supplier or designer and the purchaser mutually understand is to be irrigated by the sprinkler system.

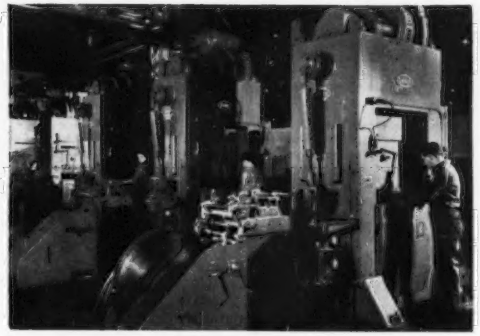
Sprinkler Irrigation System. This includes all equipment required to apply water to the design area, from the source of water supplying the system to the revolving sprinkler, nozzles, or perforated pipe. *(Continued on page 170)*

You get both...

QUALITY AND LOW COST

with REX® Pressed Steel Detachable Chain



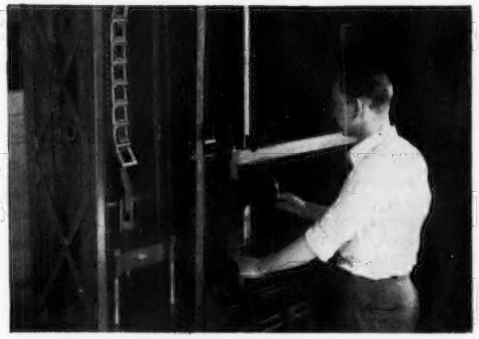


HEAT-TREATMENT

All Rex Steel Detachable Chains are pressed from special analysis strip steel and are heat-treated in continuous atmospheric controlled furnaces on a "timed" conveyor which assures precision control of heating and quenching. The degree of heat-treatment is scientifically determined to develop the ultimate in long life and resistance to wear.

PRECISION MANUFACTURE

The chain is precision-cut, formed and assembled in progressive operations on specially designed, modern, automatic presses. Blanked centers are rolled back each way to form the hook and locking bar. Links are so designed that they stay coupled while at work—yet may be easily uncoupled when chain removal is necessary.



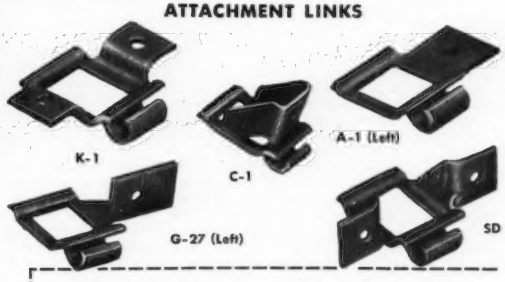
INSPECTION AND TESTING

At regular intervals samples of all Rex Steel Detachable Chain are tested for ultimate strength. In this test, the machine gradually applies increasing load to the chain, and the load is precisely weighed through a sensitive balance and recorded. This check verifies the uniform strength which has been built into the chain.

There's the Proper Attachment for Every Conveying Job

Many types of standard attachments are made for Rex Pressed Steel Detachable Chain. These attachments permit design and construction with a minimum of difficulty of many different types of conveyors. Some of the most commonly used attachments are illustrated below.

ATTACHMENT LINKS



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AGRICULTURAL CHAINS

CHAIN BELT COMPANY
of MILWAUKEE

Chain Belt Company
1680 W. Bruce Street
Milwaukee 4, Wisconsin

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Gentlemen:
Please send me a copy of bulletin 49-26.

Name.....

Company.....Dept.....

City.....State.....

RESEARCH NOTES

A.S.A.E. members and friends are invited to supply, for publication under this heading, brief news notes and reports on research activities of special agricultural engineering interest, whether of federal or state agencies or of manufacturing and service organizations. This may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Mich.

USDA AGRICULTURAL ENGINEERING RESEARCH

EVIDENCE that sustained research may be setting the stage for another upsurge in crop improvement and food production efficiency in a period when it may be badly needed is presented in the annual report of the Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA, highlights advancements in processing and handling products on the farm and engineering improvements that increase efficiency and simplify farm operations.

Machines and attachments are reported under study that cultivate, fertilize, and spray for weeds or insects in one pass over a field. This principle of combining several practices into one operation, the research chief points out, appears to offer opportunity for reducing farm costs. Farm-type grain driers have now been perfected to the point where field shelling of corn has definite possibilities. Work on ways of simplifying the application of chemicals to farm crops, complete weed-control programs as a phase of good crop management, and new uses of plant-growth regulating compounds are reported.

Mechanical Apple-Crate Dumper. Sixty to 70 per cent of the bruising received by apples when hand dumped is eliminated through the use of a new mechanical apple crate dumper. A full report on this low-cost, dependable mechanical dumper developed for use in commercial fruit-packing plants by agricultural engineers of the U.S. Department of Agriculture in cooperation with the Michigan Agricultural Experiment Station is available in reprinted article 33-23, Michigan Agricultural Experiment Station Quarterly Bulletin.

The dumper replaces hand dumping and operates from a platform holding the full apple crates. Full crates are brought to the dumper on a roller conveyor at dumper platform level and with a spring and lever arrangement the operator lifts the crate to the receiving belt level and pivots it to dumping position. An adjustable, padded-crate lid holds the apples in the crate while they are being positioned for dumping and then swings open allowing the apples to flow onto the receiving belt in a single layer. Brushes and the eliminator belt do their best work when fruit reaches them in a single layer. When the crate is empty, the operator swings it to its original position with the mechanism and removes it from the line.

The new dumping machine was operated daily during and after the 1950 apple season without needing alteration or adjustment, the research engineers report. Devised and tested in one phase of a project under the Research and Marketing Act of 1946, it is expected to be commercially available to apple-packing plants for the 1951 season. Plans for the new dumping device may be obtained from the Michigan Agricultural Experiment Station, East Lansing, Mich.

New Cleaner for Roughly Harvested Cotton. Changes in cotton production machinery and practices have brought ginners new problems, especially in such matters as conditioning and cleaning. One of the results of studies in this field by agricultural engineers of the U.S. Department of Agriculture is described in Circular 858, The Flow-Through Lint-Cotton Cleaner, a device developed to do a better job of cleaning mechanically harvested and roughly harvested cotton at the gin.

Authors of the new Circular, Victor L. Stedronsky (BPISAE) and Charles S. Shaw, cotton branch, PMA, explain that in general such cotton, at the stage in which the seed is separated from the fiber, does not tolerate further cleaning without damage to the fiber. It was determined that if fiber clean enough to meet the demands of the mills was to be turned out, there would have to be further cleaning after separation of the fiber and seed. Accordingly, this new machinery was developed. It is installed between the gin and the compressor.

The machine described in the new 30-page circular is the result of almost 10 years of investigation and trial. The new cleaner is said to be able to improve the grade of roughly harvested cotton an average of two-thirds of a grade over the lint from similar cottons turned out in gins without this new equipment. They estimate that this additional cleaning will cost about $1 per bale in a 4-stand gin handling 3,000 bales per season. A copy of Circular 858 may be obtained from the Office of Information, U.S. Department of Agriculture, Washington, D.C.

Northeast Farm Building Plans Catalog. A revision of the U.S. Department of Agriculture, Miscellaneous Publication 278, Plans of Farm Buildings for Northeastern States, Revised, known in the Northeast as "The Brown Book," has just come off the press. This is a catalog illustrating 103 plans for farm service buildings which were selected by the Plan Exchange Service Committee for inclusion in the Northeastern Plan Service. These include various types of barns, milk and dairy houses, cattle shelters and equipment, hog houses, poultry houses, storage buildings, processing buildings, and others. W. C. Harrington, extension agricultural engineer, University of Massachusetts, was chairman of the committee.

Some of the plans shown in the catalog are revisions of plans formerly in the Northeast plan service although most of the plans are new. The majority of the new and revised drawings were prepared in the division of farm buildings and rural housing, USDA. J. Robert Dodge of the division was responsible for the preparation of the drawings and the catalog. Those familiar with the old catalog will find one important difference in that only service buildings are included. Farmhouse plans selected for the region are illustrated in a separate publication, Miscellaneous Publication 658, Farmhouse Plans for Northeastern States, which was published in 1949.

As in the original catalog most of the illustrations are reproductions of the working drawings although in some cases block plans and perspectives are used instead. Complete working drawings for the plans shown in this catalog are available at a nominal cost from the extension agricultural engineer located at the State College in most of the Northeastern states.

The catalog itself is available only by purchase from the Superintendent of Documents, Government Printing Office, Washington 25, D.C. at a cost of $1. Copies of the catalog are being furnished to extension agricultural engineers in all states and the county agents in all Northeastern states.

Cigar Tobacco Curing. Success of recent cigar-tobacco curing research conducted by the USDA's Farm Electrification Division in cooperation with the Connecticut Experiment Station, is told in the recent report of William A. Junnila who is heading the Storrs project. He says that the use of research-developed gas-fired equipment instead of conventional charcoal burners for curing cigar tobacco has resulted in fuel savings as high as $65 an acre of tobacco cured. The quality of tobacco cured with gas-fired equipment was increased as much as $375 an acre. Latest reports indicate growers are planning to install enough gas-fired equipment in 1951 to cure the tobacco from a thousand acres.

Poultry Blindness Study Initiated. A cooperative investigation has been set up with the Connecticut Agricultural Experiment Station department of animal diseases to determine the relationship of ammonia concentration and relative humidity with the incidence of blindness in poultry. They are now in the process of building nine specially designed cabinets for housing the poultry to be tested. Controlled conditions within these cabinets will allow the investigators to study poultry blindness under nine different conditions of ammonia concentration and relative humidity.

Requirements for Sprinkler Irrigation

(Continued from page 168)

If water is already available to the design area, the system includes only the equipment required to develop the necessary pressure and apply the water to the area.

If both water and pressure are available, as in the case of an existing pressure line, the system includes only the equipment required to take water under pressure from the supply line and apply it to the design area.

Sprinkler Lateral. A line of portable pipe or tubing with sprinklers, nozzles, or perforations along the line. A lateral may be one of several operated from a common main supply line, or it may be a single unit supplied directly from the water source.

Application Rate. The equivalent rainfall rate expressed in inches of water depth per hour (acre-inches per acre per hour). For systems with rotating sprinklers, the rate is computed on the basis of the spacing of lateral settings, the spacing of the sprinklers along the lateral, and the average discharge of the sprinklers. For perforated pipe systems, the application rate is computed from lateral spacings, length of lateral, and average flow into the lateral.

Infiltration Rate. The rate at which soil will take in water during the irrigation period, expressed in inches of water depth per hour (acre-inches per acre per hour).

Peak Moisture Demand. Peak moisture demand of any crop is considered to be the maximum that occurs during periods of maximum temperature and crop growth. This peak demand for moisture on the part of a crop results from transpiration by the plants, and direct evaporation from the soil.

3 of the REASONS for Equipping YOUR Truck with MECHANICS *Roller Bearing* UNIVERSAL JOINTS

Use 8 Less Bolts for Assembly

this will save you approximately 12 minutes of assembly time for installing the propeller shaft in your truck.

12 minutes at $1.60 per hour = ... $.32

Are 34% Lighter in Weight

on a transport type truck this amounts to 28 pounds. This adds up to 11,200,000 pounds of extra PAYLOAD your truck can carry during its life of 400,000 miles.

5,600 ton miles at $.05 per ton mile = $280.00

Need 80% Less Down-Time for Servicing

The average truck requires 4 trips to the shop for universal joint replacement parts during its life. Each trip ties up the truck 1-1/5 hours on the average.

80% of 5 hours down-time at $3.00 = $12.00
80% of 5 hours mechanic's time at $2.00 = $8.00

Total Dollar Value of Equipping Your Truck with Mechanics Universal Joints $300.32

These 3 Dollar Value reasons for equipping YOUR trucks with Mechanic's Universal Joints are but a few of the many competitive advantages our engineers will gladly detail for you.

MECHANICS UNIVERSAL JOINT DIVISION
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NEWS SECTION

Kummer Heads Southeast Section

F. A. KUMMER, head, agricultural engineering department, Alabama Polytechnic Institute, was elected chairman of the Southeast Section of the American Society of Agricultural Engineers at the Section's annual meeting held February 5-7 in Memphis, Tenn., in conjunction with the annual convention of the Association of Southern Agricultural Workers. During the past year Mr. Kummer served as first vice-chairman of the Section. The retiring chairman is T. N. Jones, agricultural engineer, Mississippi Agricultural Experiment Station.

Other officers elected included the first vice-chairman, E. T. Swink, associate agricultural engineer, Virginia Agricultural Extension Service, and the second vice-chairman, S. C. Smith, agricultural engineer, International Harvester Co., Memphis. G. H. Dunkleberg, associate agricultural engineer, Clemson Agricultural College, is the new secretary of the Section.

The meeting was well attended and the excellent program was thoroughly enjoyed by those present. While the official registration was 74, approximately 100 attended the various sessions and 70 the banquet. In addition to the 3-day technical program, the group participated in the ASAW general sessions, took a trip through the International Harvester Plant at Memphis, and heard an address by ASAE President Fred C. Fenton, on progress in agricultural engineering, at the annual Section dinner.

Papers were given on a large variety of subjects. The meeting opened with a rural electric program featuring recent results of ultraviolet in animal production, brooding poultry with infrared energy, and a panel discussion on electricity for brooding poultry in the Southeast. At a second rural electric session, papers were given on feed grinding and mixing as a community enterprise, feed grinding on the farm, how the youth program is conducted in South Carolina, the youth program in Georgia, the use of soil-heating cable in the production of tomato and potato plants, trends in the use of electric heat in the curing and storage of sweet potatoes, and the practicability of electric barn cleaners.

Subjects covered on the soil and water program the first day were knowledge of soil properties as a tool for the conservationist and engineer, application of mulch-tillage practices in the production of small grains and supplemental pastures and a panel discussion on application of soils information in conservation work. The second day the topic for the soil and water program was water resource problems in southern agriculture covering water resources as a key to southern agricultural advancement, southern water resource problems, and increasing consumptive use and decreasing ground water supplies as challenges to the agriculturalist. On the third day, research in drainage was discussed with papers on techniques of drainage research in Virginia, results of open-ditch drainage studies, drainage and use of soils along the South Atlantic coast, drainage research in Florida and tile drainage under quicksand conditions.

Housing needs of southern rural families opened a session on rural housing followed by papers on materials most adaptable and available for low-cost homes in the Southeast, and on the responsibility of agricultural engineers in rural housing. A second session included discussions on a practical house and farm building plan service, trends and problems in storing farm crops in the Southeast, and design and operation of a seed-drying, cleaning, and grading plant.

Subjects heard on the power and machinery program included progress of cotton mechanization in the Southeast, the use of butane and propane as a fuel, machinery for mulch seeding of supplementary grazing crops in permanent pastures, and cotton-insect control with cultivator spray machines. A final session on processing of farm crops covered technical requirements and equipment for drying baled hay, physical characteristics and requirements of LP-gas and liquid-fuel burners for crop processing and drying plants, and a panel discussion on crop processing, covering equipment for processing farm crops, commercial processing for seed handling, and extension work and research work in processing, storage and drying, and the plant physiological problem in seed processing and storage.

Samuelson New Chairman of Minnesota Section

MARVIN J. Samuelson, engineer, tractor division, Minneapolis-Moline Co., was elected the new chairman of the Minnesota Section of the American Society of Agricultural Engineers at the annual meeting of the Section held January 25. He succeeds Marvin Nabben, agricultural engineer, Northern States Power Co.

Other officers elected included the new vice-chairman, Wayne E. Schober, chief engineer, Viking Tool and Die Co., Minneapolis, and C. H. Christopherson, associate professor of agricultural engineering, University of Minnesota, the new secretary-treasurer. Curtis L. Larson, University of Minnesota, was elected to a two-year term as director and Section representative of the Minnesota Federation of Engineering Societies. Marvin Nabben and Ortie LaVoy, Weyerhaeuser Sales Co., were elected alternate director and contributing editor, respectively, of MFES. The new nominating committee of the Section includes E. R. Allred (chairman), C. P. Wagner and A. C. Heine.

The spring meeting of the Minnesota Section will be held on the St. Paul campus of the University of Minnesota on Friday, April 20. It will be an all-day meeting with technical talks in the morning, a luncheon at noon, an industry tour in the afternoon, and a dinner and speaker in the evening. Agricultural engineers and agricultural engineering students from the states of Minnesota, Wisconsin, Iowa, North Dakota and South Dakota are invited to attend the meeting.

A.S.A.E. Meetings Calendar

March 23 and 24—SOUTHWEST SECTION, Grim Hotel, Texarkana, Tex.

March 23 and 24—MID-CENTRAL SECTION, agricultural engineering building, University of Missouri.

April 20—MINNESOTA SECTION, agricultural engineering bldg., University Farm, St. Paul.

May 11 and 12—VIRGINIA SECTION, Patrick Henry Hotel, Roanoke, Va.

June 18-20—ANNUAL MEETING, Rice Hotel, Houston, Tex.

August 27-29—NORTH ATLANTIC SECTION, Chalfonte-Haddon Hall, Atlantic City, N. J.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to A.S.A.E., St. Joseph, Michigan.

John Nicholas Elected ASAE Fellow

HAVING been nominated by five members of the Society, all of them of the grade of Fellow, John E. Nicholas, professor of agricultural engineering, Pennsylvania State College, was last month elected by the Council of the American Society of Agricultural Engineers to the grade of Fellow. Mr. Nicholas is a mechanical engineering graduate of Lehigh University, and has a master of science degree in mechanical engineering from Massachusetts Institute of Technology. He has been a member of the agricultural engineering staff of Pennsylvania State College, specializing in rural electrification, since 1929.

Beginning January 1, 1951, the grade of Fellow of ASAE has been advanced to honorary status, to which engineers of distinction may be elected but for which they may not apply. Requirements for the grade of Fellow are 20 years of active practice in the profession of engineering and 10 years in the grade of Member of ASAE.

Demonstration Models' Exhibit for 1951 ASAE Annual Meeting

THE ASAE Committee on Extension is sponsoring the third annual exhibit of demonstration models in connection with the 44th annual meeting of the Society to be held next June 18 to 20 at Houston, Texas. Keith H. Hinchcliff, chairman of this exhibit, urges participation by all interested individuals, schools, and companies, and announces that appropriate awards will be made to the entries judged best in each class.

Two classes of models will be exhibited this year: Class 1 will include models having non-patented devices or processes, and class 2 will consist of models featuring patented devices or processes. Class 1 will further be subdivided into group 1, portable demonstration models which can be handled by one man or are small enough to fit in the trunk of a car, and group 2, large demonstration models which are relatively non-portable.

Entry requirements stipulate that each model should feature a useful basic principle and should show how to do something. In addition, the exhibit should be available to educational leaders or be reproducible without highly trained skill or equipment and not patented. As an example, the principle of a model might be to reduce farm chore labor; the how to do might be to show how to feed livestock mechanically; and the availability would be that it could be built in an average school shop.

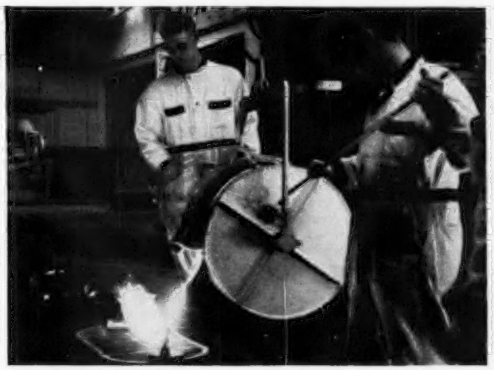
Individuals and organizations who wish to enter this demonstration models' exhibit may secure special entry forms from the ASAE, St. Joseph, Michigan, or they may supply the information needed by the Committee as indicated below. In brief, the *(Continued on page 174)*

How new research foundry creates better IH castings

A report to you about men and machines that help maintain International Harvester leadership

Million-dollar Research Foundry, IH college of casting knowledge, has a two-fold objective: 1. To improve foundry techniques. 2. To develop skilled foundrymen. This ultra-modern direct-arc electric furnace helps to make the IH research foundry one of the largest and most completely mechanized research foundries in America.

Sand technician tests molding mixes by the hundreds to find the perfect formula. He uses delicate instruments in the modern foundry laboratory to measure differences in strength and moisture transfer of look-alike sand mixtures. His recommendations can mean the difference between molds which produce poor or perfect castings.



College men get calluses and competence by working at every job in the IH research foundry. This firsthand knowledge of foundry methods helps these young engineers use their scientific training to solve practical problems. Some of these trainees will make research their career . . . others will put their know-how to work in the ten IH foundries.

IH researchers test rather than guess. Here's a foundry trainee checking the strength of an IH casting. His arsenal of testing equipment includes a million-volt x-ray, an electron microscope, and countless other scientific devices. It makes possible the collection and correlation of facts needed to create better gray and malleable iron castings.

INTERNATIONAL HARVESTER

International Harvester Company, Chicago 1, Illinois

International Harvester Builds McCormick Farm Equipment and Farmall Tractors . . .

Motor Trucks . . . Crawler Tractors and Power Units . . . Refrigerators and Freezers . . .

NEWS SECTION *(Continued from page 172)*

Committee desires to know the name and address of the company or school entering the exhibit and also the individual who will be responsible for the exhibit at the meeting. The entry application should state the basic principle, what it shows how to do, the availability or reproductibility and the classification of the model. In order to arrange for exhibit space at the Rice Hotel, the Committee desires to know the length and depth of table needed and the wall area. Whether an electric outlet or other special props are needed should also be indicated. Exhibitors should further indicate whether they will bring the model to the meeting or ship it to the Rice Hotel, and give its expected time of arrival.

ASAE members who cannot bring or send their demonstration models to Texas should consider entering a photograph of it in 2 x 2-in slide form. These can be presented at the special Extension Committee session and will be considered for awards in a special classification. All entry forms should be addressed to K. H. Hinchcliff, agricultural engineering dept., University of Illinois, Urbana, Ill.

Educational Motion Picture Competition

THE Committee on Extension of the ASAE is again scheduling a competition to determine the most outstanding motion picture, in the field of agricultural engineering, produced during the Society year, June, 1950, to June, 1951.

The Committee stresses the fact that the how-to-do type of film will be the basis of judging the films entered in the competition. While it is permissible that films entered have some advertising in them, such as the name of the company or showing of the company's products, they should not be typically advertising or promotional films, but rather films produced essentially for educational purposes.

Below is a copy of the score card indicating the basis of judging the films.

Those who desire to submit films in this competition should ship them direct to I. D. Mayer, agricultural engineering building, Purdue University, Lafayette, Ind., and they should reach Mr. Mayer not later than May 10. All films submitted will be reviewed by the Committee at Lafayette during the week of May 14. Awards will be made at the time of the Society's annual meeting in Houston, Texas, June 18 to 20. The first two or three films having the highest ratings will be shown during the session of the Committee on Extension at the ASAE annual meeting or at some other designated time during the meeting. Following is the score card which indicates the basis on which the films submitted in this competition will be judged:

Technical quality	10 points
Freedom from annoying distractions and advertising	10
Proper scene length, editing	5
Do scenes tell the story in logical sequence?	5
Proper scene sequence	5
Proper framing and picture area utilization	5
Does film hold interest?	20
Narrator	10
Educational value	10
Inspirational value	10

Bulletins and Manual Display

THE ASAE Committee on Extension will sponsor another "best bulletins" and "classroom manuals" display, along with other educational exhibits which it is arranging in connection with the Society's 1951 annual meeting at Houston, Tex., June 18 to 20. Following are the entry rules covering these two displays:

BEST BULLETINS

1 Entries must be educational in nature. Bulletins published by commercial concerns must not contain over 20 per cent advertising.

2 Entries must have been produced since May 20, 1950. (Members have had an opportunity to submit earlier bulletins at previous meetings.)

3 Entries must classify as to "industrial" or "public agency."

4 Submit four (4) copies. (Judging will be done before the June meeting.)

5 All bulletins are to be printed publications. (Single sheet mimeographed or duplicated forms will not be accepted.)

6 Entries will be judged on: first impression, organization of material, readability, action inspiration, and low cost.

7 Ribbons will be awarded to all "Blue Ribbon" winners.

8 All entries must be submitted by May 20, 1951. Four copies of your best bulletin should be mailed to Milton R. Dunk, Poultry Tribune, Mount Morris, Ill.

CLASSROOM MANUALS

1 Since this is a relatively new exhibit, classroom manuals produced by public agencies and industry during the past four years may be submitted.

2 Entries must classify as to "industrial" or "public agency."

3 Submit four (4) copies.

4 Entries will be judged on the following considerations: first impression; readability; adapted to the needs, interests and maturity level of students and sound in terms of the program they seek to supplement.

5 If material is prepared by a commercial company, it must be free from obvious promotion.

6 Ribbons will be awarded to all "Blue Ribbon" winners.

7 Send four copies of classroom manuals to Milton R. Dunk, Poultry Tribune, Mount Morris, Ill., by May 20, 1951.

NEW BULLETINS

Testing and Rating Propeller Fans, by W. D. Scoates and Arthur W. Melloch. Texas Engineering Experiment Station (College Station), Research Report No. 12, April, 1950. Brief information on procedure, with special reference to NEMA, NAFM, and ASHVE codes and their applications.

Chipped Wood Production and Uses. Bulletin 33 (January, 1951) Northeastern Wood Utilization Council (PO Box 1577, New Haven 6, Conn.) $2.00.

This bulletin publishes papers and discussion presented at a joint conference on the subject held September 15 at Marlboro, Vt. Included titles are wood chips and farming, possibilities of wood chipping in forest management, stationary chippers for processing low quality and waste wood, portable wood chipping equipment, a pilot study of the use of light, portable wood chippers, land clearing, power lines, pulpwood operations, mulch for berries, decomposition of wood chips in soil, wood chips as a soil amendment, material for compost, wood chips as a bedding material for dairy cows, wood chips as bedding, pulpwood, the saturated felt industry in the Northeast, wood chips for use in roofing felt manufacture, wallboard, and fuel. Appendixes list manufacturers of chippers, report on operation of a chipper at Sturgeon Falls, Ontario, and test on wood chips for pulp.

Adequate Farm Wiring, by Joseph A. McCurdy and Elwood F. Olver. Circular 373 (November, 1950) Pennsylvania State College (State College).

This extension circular explains to farmers the need and importance of adequate wiring and includes recommendations which, if followed will provide it. Recommendations cover a meter pole, load center system.

Water in Industry. A survey of water use in industry by the National Association of Manufacturers (14 West 49th St., New York 20, N. Y.) and the Conservation Foundation (30 East 40th St., New York 16, N. Y.).

This bulletin reports findings in terms of national summaries on intake, sources, uses, reuse, treatment for use, treatment of waste, disposal of waste, water supply activities, water use per unit of product, and use of salt water. Findings are also reported by regions and localities for water intake, reuse of water, potentialities for expansion of water use, and water pollution.

Groundwater Resources in Champaign County, by H. F. Smith. Illinois State Water Survey Division (Urbana) report of investigation No. 6. This reports on the history of municipal water supplies in the area and on levels and movement of groundwater.

The Clip-Oil for Controlling Tobacco Suckers, by Robert W. Wilson. Information Series No. 3, Department of Agricultural Engineering, North Carolina Agricultural Experiment Station. This is a special industry bulletin to inform farm equipment manufacturers of a new equipment item available for manufacture under agreement with the department, which has applied for patent rights. It invites manufacturers to study the development and submit proposals for mass production.

The bulletin explains that topping and suckering have been proven to increase substantially the per acre yield value of flue-cured tobacco. Scarcity and cost of labor has limited the economy and adoption of these practices. Mineral oils applied to leaf axils have been found to inhibit the growth of sucker buds. The clip-oil device combines a hand-pruning shear for topping, with an applicator for mineral oil which runs down the stalks to the leaf axils. Labor savings of $10 to $22 per acre are indicated.

Water Spreading (2nd edition), J. I. Case Co. (Racine, Wis.). A 16-page illustrated guide to land preparation for water spreading to conserve and utilize runoff from flash rains.

Men, Mills, and Timber, Weyerhaeuser Timber Co. (Tacoma 1, Wash.) A well-illustrated story on progress in forestry, forest product improvement, and by-product development, covering the half-century history of the company, appropriately printed on three types of wood pulp paper.

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AGRICULTURAL
INDUSTRIAL
FIRE
MARINE

The Questionable Future of Agricultural Spraying in 1951

The effective control of insects and weeds by low pressure spraying is attested to by the hundreds of thousands of bronze rotary gear pumps Oberdorfer has placed in the field during the past four years. Our Federal Government, in this emergency, requires substantial crop production increases for the coming season.

From cotton in the Mississippi Delta thru wheat in North Dakota, oats in Oregon and on to tobacco in the Carolinas, the harvest of most every major agricultural crop in this country may be materially increased by following recommended local spraying procedures. This will involve the use of a spray machine equipped with one of the many styles and types of all-bronze, low pressure rotary gear pumps for which this company has been the internationally accepted manufacturing standard for over fifty years.

There is no question but that there will be an acute shortage of such low pressure spraying equipment as a result of the increased acreage to be sprayed plus the recently approved low pressure spraying program about to be placed in operation on a large scale thruout the cotton belt. There will not be enough pumps to go around.

We request that all dealers and distributors of spraying equipment using the Oberdorfer Pump estimate their demand without delay and place their orders with spray equipment manufacturers as soon as possible. Then we both may present to the Director of the Office of Production & Marketing Facilities, U. S. Dept. of Agriculture, in Washington, concrete evidence of our metal requirements so that metal may be allocated by the Federal Government in sufficient time to be of use in the 1951 spraying season.

Agricultural Pump Division
Oberdorfer Foundries, Inc.
Syracuse 1, New York

ESTABLISHED SINCE 1895

PERSONALS OF ASAE MEMBERS

Louis Decatrel, formerly director general of agriculture, Haiti Department of Agriculture, was appointed in December as Secretary of State for Agriculture by the President of Haiti.

John Heilman recently resigned as agricultural adviser to Instituto Agrario Nacional of the Ministry of Agriculture of Venezuela to establish a professional farm management service in that country. In connection with this new activity he has signed one contract with IAN and is preparing for that organization an over-all operations manual for use in establishing and operating their agricultural projects.

Kendrick M. Hickman was recently appointed manager of agricultural sales for the Ewart plant of Link-Belt Company, Indianapolis, Ind. Since 1946 he has been serving as sales engineer contacting farm machinery manufacturers on their chain and sprocket requirements. He is a mechanical engineering graduate of Purdue University and Armour Institute and has been in the employ of the Ewart plant of Link-Belt since 1927.

Earl G. Johnson has returned to his former position as zone conservationist at the Milwaukee regional Office of the U.S. Soil Conservation Service. For two years he was assigned as agricultural engineer in the Agriculture Division, Natural Resources Section, General Headquarters of the Supreme Commander for the Allied Powers in Japan, to assist the Japanese government in its program of land reclamation and improvement. In this work he gave particular attention to reorganization of the governmental administrative agency responsible for land-development operations, formulation of detailed scientific criteria for selection of land suitable for reclamation, allocation of resources to land damage repair work, planning of reclamation areas, settler selection and establishment, and development of detailed technical material on engineering, drainage and irrigation. In the course of his tour of duty he travelled extensively throughout Japan, his work taking him into more than 100 Japanese rural communities in 27 out of the 46 prefectures of Japan. On leaving Japan he was warmly praised for his outstanding service in the work of the Occupation.

John W. Rockey has accepted appointment as administrative assistant in charge of business operations, Divisions of Agricultural Engineering (BPISAE), U.S. Department of Agriculture. Previous to this appointment, he had been assistant to Wallace Ashby, head of the Division of Farm Buildings and Rural Housing. Mr. Rockey's office will remain at the USDA Research Center, Beltsville, Md.

Necrology

CURTIS V. EDWARDS, owner and president of Edwards Equipment Co., Yakima, Wash., was one of ten victims of an airliner crash near Edwall, Wash., January 16. He was returning to Yakima from a business trip in the Midwest at the time. Born at Wheatland, Mo., in 1891, his family first moved to Redlands, Calif., in 1899, and established its home there in 1907. He attended the University of Redlands and later supplemented his general education with special studies in mechanical engineering. From 1915 to 1920 he was superintendent of a machine shop in Redlands. In 1920 he established himself as owner of a machine shop and farm machinery business at Anaheim. In 1923 he returned to Redlands as purchaser and operator of the machine shop business of his former employer. During 1925 and 1926 he served as superintendent of construction, building roads, pipelines, and reservoirs for the Big Bear Lake Land Co. From 1926 to 1928 he was manager of Redlands Motor Car Co. In 1928 he purchased and operated a farm equipment business at Redlands, in which he built special items of farm machinery and sold a general line of farm equipment. He operated this business until 1940, when he moved to Portland, Ore., as president and design engineer of Plywood Equipment Co. During 1942 and 1943 he was back in California, at Fontana, as inspector of machine installation and steel erection for Kaiser Co. Since April, 1943, he had been located at Yakima, first as chief design engineer for Linderman Power Equipment Co., and later as head of his own manufacturing company. Mr. Edwards was elected to membership in ASAE in 1945 and has been active in the organization and meetings of the Pacific Northwest Section, and was a past-chairman of the Section. Funeral services were held by the First Presbyterian Church at Yakima, January 22, and memorial services February 1, by the First Baptist Church at Redlands where he had long been an active member. He is survived by his widow, Florella Lambert Edwards; a son, Jack, who was a patient in the Marine Corps Naval Hospital at Oceanside, Calif., at the time; and two sisters, Mrs. Mada A. Krull of Mentone, and Mrs. Zulah Humphrey of Huntington Park.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Amacher, George A.—Agr. engr. (BPISAE), USDA. (Mail) 3725 Van Ness St., N.W., Washington 16, D.C.

Berry, Joseph N.—Test engr., Dearborn Motors Corp., 15050 Woodward Ave., Detroit, Mich.

Bouilliant-Linet, Frances J.—Harry Ferguson Ltd., Coventry, England.

Brakenseik, Donald L.—Graduate student in agr. eng., University of Ill. (Mail) 809 South 5th St., Champaign, Ill.

Brooks, Charles P.—Work group engr. (SCS), USDA. (Mail) 805 Court, Fulton, Mo.

Brown, Eugene C., Jr.—Asst. ext. agr. engr., Texas A & M College, College Station, Texas

Deer, Richard K.—Power-use advisor, Indiana-Michigan Electric Co. (Mail) 608 E. Pa. Ave., South Bend 18, Ind.

Fisher, Howard F.—Bridge designer, Iowa State Highway Commission. Ames, Iowa. (Mail) 221 Hyland

Fisher, William H.—Sales engr., Gulf Oil Corp. (Mail) 3281 S.W. 20th St., Coral Gables 34, Fla.

Hein, Harold W.—Product des. engr., McCormick Works, International Harvester Co. (Mail) 3120 N. Lawndale Ave., Chicago 18, Ill.

Hogan, Howard B.—Irrigation pump dept., Western Land Roller Co., Hastings, Nebr. (Mail) 715 Turner Ave.

Hudgins, Oswald D.—Blockman, Allis-Chalmers Mfg. Co. (Mail) 1139 St. Louis Pl., N.E., Atlanta, Ga.

Jacob, Frederic C.—Asst. spec. in agr. eng., University of California, Davis, Calif.

Kadir, Naji A.—Graduate student, irrigation dept., Utah State Agr. College (Mail) PO Box 25, Logan, Utah

Kendall, Edwin K.—RR 18, Box 429, Indianapolis, Ind.

Kulhavy, Joseph T.—Tractor eng. supervisor, J. I. Case Co. (Mail) 1322 West 15th St., Davenport, Iowa

Lambert, Ralph C.—Service mgr., Florida Ford Tractor Co., 2575 West Fifth St., Jacksonville, Fla.

Mohorn, Vernon L., Jr.—Zone manager, Doolittle Tractor and Implement Co. (Mail) 16 Laneau Dr., Greenville, S.C.

Moore, Archie E.—Manager, farm equip. dept., Farm Bureau Services, Inc., 221 N. Cedar, Lansing, Mich.

Netman, Edgar C.—Agr. missionary, Escuela Agricola & Industrial, Preston, Oriente, Cuba

Pearce, Leon B.—Field engr., Fairbanks Morse & Co. (Mail) 208 South 1st St., Council Bluffs, Iowa

Randolph, William J.—Asst. engr., State Conservation Commission. (Mail) Box 288, Ankeny, Iowa

Reichard, William B.—Rural rep., Pennsylvania Power Co. (Mail) 194 Main St., Greenville, Pa.

Robinson, Charles A., Jr.—Electrical engr., National Rural Electric Cooperative Assn., 1303 New Hampshire Ave., N.W., Washington, D.C.

Robinson, W. E.—856 No. 3 Rd, Brighouse, B.C., Canada

Rosenthal, Henry L.—Pres., Rosenthal Corn Husker Co., 8229 West Greenfield Ave., West Allis 14, Wis.

Schmidt, William R.—Div. engr., J. I. Case Co., Rockford Works, Rockford, Ill. (Mail) Engr. dept.

Scofield, John E.—District ext. agr. engr., Cornell University. (Mail) 9 Rose St., Cobleskill, N. Y.

Sherts, James H.—Director, product dev. dept., Pittsburgh Plate Glass Co., 2000 Grant Bldg., Pittsburgh 19, Pa.

Skinner, Halver M.—Assoc. prof. of agr. engr., Montana State College, Boseman, Mont.

Smith, Eduard M.—Instructor, vo-ag dept., Southwest Texas State Teachers College. (Mail) 530 West San Antonio St., San Marcos, Tex.

Stacey, William A.—Field engr., service bureau, American Wood Preservers Assn. (Mail) 1939 New Hampshire, Lawrence, Kans.

Waggener, Allen M.—Conservation engr., Fort Apache Indian Agency. (Mail) Box 2, Whiteriver, Ariz.

Webb, Charles H.—Asst. county agent, Ala. Ext. Service. (Mail) Dadeville, Ala.

Williams, Herbert J.—Farm engr., Colorado Central Power Co., 3470 South Broadway, Englewood, Colo.

Woods, F. Reginald—Agr. asst. in soil conservation service, New Brunswick Dept. of Agriculture, Box 349, Perth, N.B., Canada

TRANSFERS OF MEMBERSHIP GRADE

Day, C. L.—Asst. prof., dept. of agr. eng., University of Mo., Columbia, Mo.

Henningsen, Eilar A.—Des. engr., experimental eng. dept., McCormick Works, International Harvester Co. (Mail) 28 Hiawatha Drive, Clarendon Hills, Ill.

Nathan, Kurt—Asst. prof. of agr. eng., National Agricultural College. (Mail) 82 Swamp Road, Doylestown, Pa.

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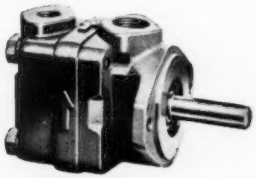
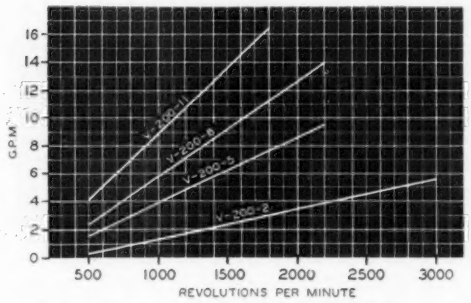


TYPICAL PERFORMANCE CURVE
AT 1000 PSI



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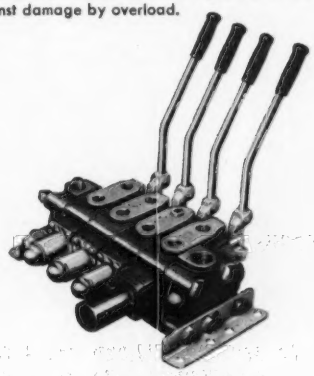
Standard interchangeable units assembled in any combination desired to lift, hold, lower, etc. Load cannot slip when valve spool is shifted. Surges and back pressure cannot interfere with easy, accurate positioning. Built-in relief valve protects entire hydraulic system against damage by overload.



Valve Capacities at 1000 psi Operating Pressure

Model Series	Pipe Size	Maximum Capacity, gpm	
		Up to 3 sections	4 or more sections
CM2-04	½"	18	14
CM2-06	¾"	24	20
CM3-06*	¾"	36	28
CM3-08	1"	48	40

*Heavy Duty

Vickers hydraulic power pack

A compact, convenient "package" consisting of Vickers Vane Pump, overload relief valve, one or more operating valves (single and double acting), oil tank and filter. Made in a variety of types and sizes for 1000 and 1500 psi operating pressure, depending upon shaft speed. Provides instantaneous, easy and accurate control by operator. Adaptable for practically all mountings and drives.

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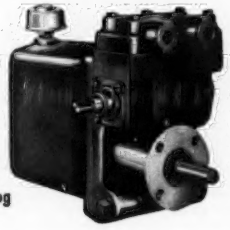
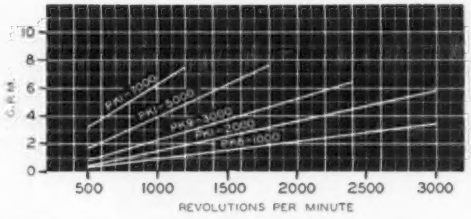


TYPICAL PERFORMANCE CURVE
AT 1000 PSI



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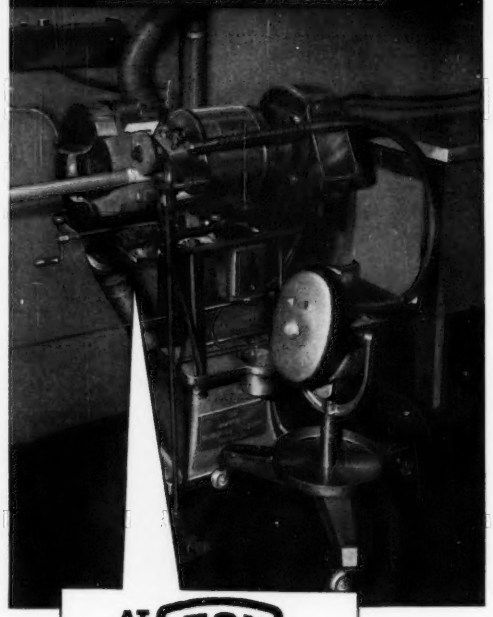

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NEW BOOKS

SERVICING AND MAINTAINING FARM TRACTORS, by Elmer J. Johnson and Alvin H. Hollenberg. Cloth, xvi+313 pages, 6 x 9 inches. Illustrated and indexed. McGraw-Hill Book Co. (New York 18, N. Y.) $3.75.

This work is offered as a practical guide and reference for the owners and operators of the more than 4,000,000 tractors on farms in the United States. It gives information on use conditions and operating principles in support of recommendations on service procedures and practices. Chapters cover setting up a servicing and maintenance program; operating a tractor safely; applying tractor power in farming; lubricating the chassis and assemblies; lubricating the engine; lubricating and servicing the transmission and final drives; servicing air cleaners; maintaining the tractor electrical system; selecting and using fuels; servicing and adjusting the carburetion and fuel systems; servicing the cooling system; servicing, adjusting, and repairing tractor tires; locating tractor troubles and making minor repairs; preparing the tractor for winter use, and cleaning, painting and storing farm tractors.

THE ENGINEERING METHOD, by John Charles Lounsbury Fish. Cloth, vi+186 pages, 6 x 9 inches. Illustrated and indexed. Stanford University Press (Stanford, Calif.) $3.00.

The material presented here is extracted and revised from the author's contribution to an earlier work, "The Engineering Profession," by Hoover and Fish (1941). It is intended as a reference and guide for undergraduate and graduate students and young practitioners and teachers of engineering, to engineers of all grades for comparison with individual methods and a guide to assistants, and to nonengineers who may be interested in the applicability of the method to problems outside of the engineering field. It covers the subject in three chapters on the method of engineering, application of the engineering method, and uncertainties in engineering.

RED TRACTOR BOOK, 1950-51. 35th annual edition. Leatherette, 524 pages, 7 x 10 inches. Illustrated and indexed. Implement and Tractor (Kansas City 6, Mo.) No price stated.

Technical specifications on farm tractors and power operated farm equipment, including basic units and component parts thereof. It includes data on balers, combines, corn pickers, corn huskers and shredders, corn shellers, engines, ensilage cutters, forage blowers, forage harvesters, hammer mills, hay presses, loaders, sprayers, and unloaders, as well as on tractors. Data on components cover air cleaners, batteries, belt pulleys, brake linings, carburetors, clutches, cooling systems, diesel injectors, distributors, drawbar and power take-offs, gages, generators and regulators, governors, hydraulic lifts, lights, magnetos, oil filters, spark plugs, starting motors, steering gears, tire, rim and valve sizes, and valve springs. Other data given include ASAE and SAE Standards, calcium chloride table, lubrication and liquid capacities, Nebraska Test Section, tappet settings, tightening torques, and tune-up data.

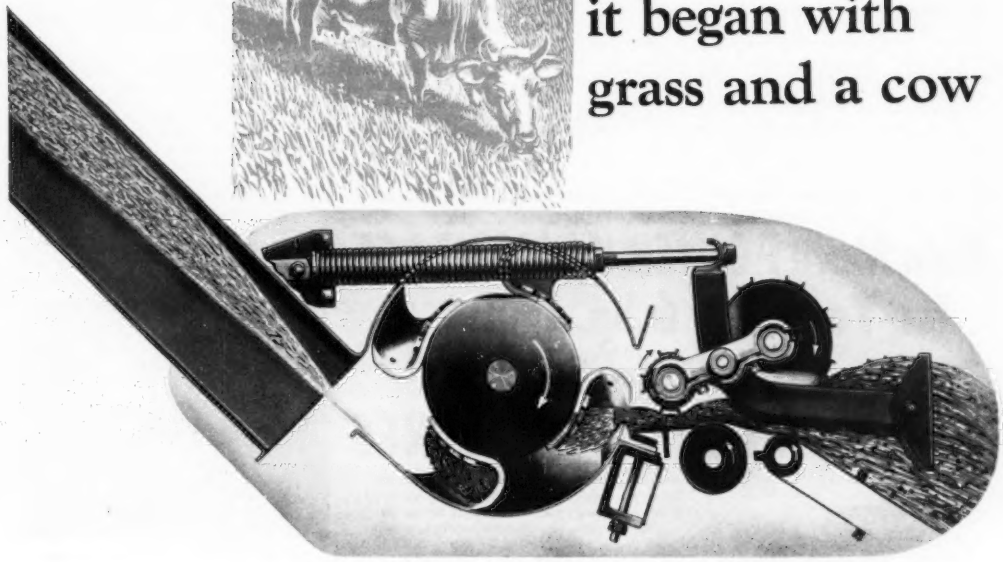
REPORT PREPARATION, by Frank Kerekes and Robly Winfrey. Cloth, xiv+448 pages, 8½ x 11 inches. Illustrated and indexed. Iowa State College Press (Ames) $6.90.

This text and reference is an enlargement of a "Manual of Report Preparation" originally issued in 1948 primarily for use at Iowa State College but found in active demand for use elsewhere. From the standpoint of use by engineers it benefits from the fact that its authors are engineers of wide experience. In breadth of treatment this is the nearest we have seen to a complete work on the subject. Chapters cover introductory matter on the importance and nature of reports, planning the investigation and report, collection of information, mechanics of style, format and arrangement, tabular presentation, preparation of illustrations, effective writing, writing the first draft and revising, correspondence, letter reports and short reports, formal reports—preliminary and supplementary parts, formal reports—body, magazine feature articles and technical papers, oral presentation of reports and technical papers, letter of application, and editing, copyreading, and proofreading.

MANUAL OF SOIL AND WATER CONSERVATION ENGINEERING, by Glenn O. Schwab, Richard K. Frevert, and Kenneth K. Barnes. Paper, x+222 pages, 5½ x 8½ inches. Spiral wire binding. Illustrated. Wm. C. Brown Co., Dubuque, Iowa. $2.50.

This is a college-level classroom and laboratory instruction manual for students in agriculture and related fields. It may also prove convenient as a reference for teachers of veterans and vocational agricultural high schools, for engineers, county extension directors, contractors, farm managers, and farmers. It suggests step by step procedures for solving field problems and illustrates a standard form for field notes. Chapters cover an introduction, field notes, measurement of distances and areas, levels and leveling, mapping, contouring strip cropping and terracing, vegetated outlets and water courses, surface and subsurface drainage, terrace and waterway construction, use of explosives, farm ponds, sprinkler irrigation, and soil conservation farming. Definitions are grouped in an appendix. Seventeen laboratory problems are included.

it began with grass and a cow



GREEN feed the year 'round — like the grass a cow harvests for herself — that was the need which Allis-Chalmers set out to meet with this Forage Harvester.

Engineering started in the field and *stayed* in the field until many problems were answered — including such tough ones as big capacity without big power demands . . . adaptability to standing hay crops, row crops, and windrows . . . protection against rocks . . . and easy, uniform sharpening of all cutting knives.

A critical inspection of the A-C Forage Harvester will disclose an outstanding example of the way agricultural engineering finds better answers to old problems — with design which begins in the field with basic needs and ends with agricultural machines that combine outstanding performance with simplicity, easy operation and reasonable cost.

The Allis-Chalmers Forage Harvester is a 3-in-1 machine, for standing grass crops, row crops and windrows.

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NEWS FROM ADVERTISERS

New Products and Literature Announced by AGRICULTURAL ENGINEERING Advertisers

Knoedler Farm-Product Booklet. Extra Profit and Pleasure on Your Farm is the title of a new booklet offered by Knoedler Manufacturers, Inc., Streator, Ill. Nine farm-tested Knoedler products are listed, with information on how each one increases the efficiency, safety and health, or comfort of the owner. The booklet is attractively designed in two colors and contains 16 pages of photographs, drawings and information, including prices. Four pages of the catalog are devoted to the Knoedler health-saving tractor seat, including such accessories as the sliding adjustment and underseat tool boxes. Other Knoedler products featured are the new safety reverse gear for corn pickers, the new portable crop drier fan, the new portable cornbelt burr mill, Mor tractor platforms, air-conditioned pan seat cushion, front-end hitch for John Deere tractors, Bruning hydraulic coupler and ball bearing spinner. Booklets are available from the manufacturer or local Knoedler dealers without cost.

New Departure Ball Bearing Catalog. The new 20th edition of the New Departure ball bearing catalog, now ready for distribution upon request to New Departure Division, General Motors Corp., Bristol, Conn., contains numerous added features of interest and value to ball-bearing users. Selection of bearing type and size for various conditions of load and speed is considerably simplified and illustrated by examples. Load-rating tables now give both radial and thrust capacities for all bearings except those types which are designed for certain specialized services, and speeds now have been arranged to include those for synchronous motors. Several more types of single-row and double-row angular contact bearings have been added.

Dearborn-Peoria Fertilizer-Grain Drill. Dearborn Motors Corp., Detroit, Mich., announces a new versatile grain and fertilizer drill which plants peas, beans, and small grains, and with grass-seeder attachment accurately drills or broadcasts grasses and legumes. One feature is a fluted force feed that meters seed from an all-metal hopper in a uniform, easily adjusted stream. The amount of fertilizer drilled can be regulated from 40 to 1,900 lb per acre by adjusting gates and drive speed. The hopper is divided into grain and fertilizer compartments, each holding approximately 6 bu. A fertilizer agitator is standard equipment. The 13 single-disk furrow openers, designed to cut through hard ground and trash, are spaced 7 in apart. A power lift, operated from the tractor seat, raises and lowers the furrow openers. Planting depth is

The Dearborn-Peoria fertilizer-grain drill

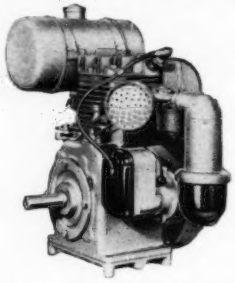
adjusted easily by moving the stop block in the power-lift link. The box-type frame is riveted, bolted and arc welded for maximum strength and rigidity to keep all working parts in alignment.

Rubber Belt with Teeth. United States Rubber Co., Rockefeller Center, New York 20, N. Y., has started large-scale production of a rubber and fabric belt with teeth which it considers the most outstanding advance in power transmission during the past 50 years. Known as the Gilmer timing belt, it fulfills the need for a power drive which will not slip and permits split-second precision timing.

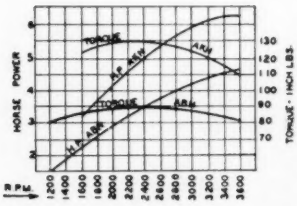
U.S. Rubber's "belt with teeth"

In addition, it will attain speeds up to 16,000 fpm, and operates more quietly than precision gears running in an oil bath. It can be manufactured in any desired size and in a variety of materials to suit specific applications. The new belt will not stretch and operates on fixed centers without take-up adjustments. It has high efficiency with extremely low bearing pressure and requires *(Continued on page 182)*

Gain More POWER ADVANTAGE for Your 3 to 6 hp. Units . . . *Specify* Single-Cylinder WISCONSIN *Air-Cooled* ENGINES



Models ABN and AKN 4-cycle, single-cylinder standard engines, 3 to 6 hp. (See specifications)



POWER CURVE AND HORSEPOWER LISTING SHOWS MAXIMUM DYNAMOMETER HORSEPOWER OF ENGINE complete with fan, muffler and air cleaner. For continuous heavy-duty operation do not rate the engine at more than 80% of the horsepower shown at any given speed.

Presented here are a few of the basic facts why Wisconsin Heavy-Duty Air-Cooled Engines offer important advantages to the designing engineer, equipment manufacturer and the ultimate user.

1. Rotary type high tension magneto, with impulse coupling, mounted on outside of engine . . . operates as an entirely independent unit that can be serviced or replaced in a few minutes.

2. Self-cleaning tapered roller bearings at *both* ends of the crankshaft . . . will withstand either side-pull or end thrust without danger to the bearings.

3. Maximum torque at usable speeds . . . most desirable for equipment that really has to go to work.

SPECIFICATIONS		Model ABN	Model AKN
Bore		2½"	2¾"
Stroke		2¾"	2¾"
Piston Displacement—cu. in.		13.5	17.8
Horsepower	1800 R.P.M.	2.5	3.6
	2600 R.P.M.	3.7	5.3
	3000 R.P.M.	4.2	5.9
	3600 R.P.M.	4.6	6.2
Main Bearings		Tapered Roller	
Piston		Aluminum Alloy	
No. of Piston Rings		3	
Connecting Rod		Aluminum Alloy Babbitt Lined	
Crankshaft	Counterbalanced	Heat Treated Drop Forging	
Cylinder Head		Aluminum Removable	
Cylinder — Crankcase		Cast Iron	
Valve Seat Insert (Exhaust)		Nickel Chrome Molybdenum Iron	
Spark Plug Size		18 mm. Metric	
Fuel Tank Capacity		1 Gallon	
Weight — Lbs.	Net	Crated	
Standard Engine	76	89	

This is the first of a series of engineering data advertisements about Wisconsin Air-Cooled Engines. Entire series yours on request. Our engineering department will be glad to co-operate with you in adapting Wisconsin Engines to your requirements. Write for further data.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46 WISCONSIN

The building that works around the clock . . .

lasts longer . . . requires no expensive upkeep . . .

and is fire-safe—the Multi-Purpose

STRAN-STEEL QUONSET

Perhaps the hardest-working, least-complaining, and most versatile piece of "equipment" you can have on your farm is a Stran-Steel Quonset building!

More than just a building, the Quonset is a valuable *tool* on any farm—a production *machine* that works with you and for you.

The Quonset reduces hours of drudgery and miles of legwork. It's designed to increase volume and cut material and labor costs. Its uses are unlimited.

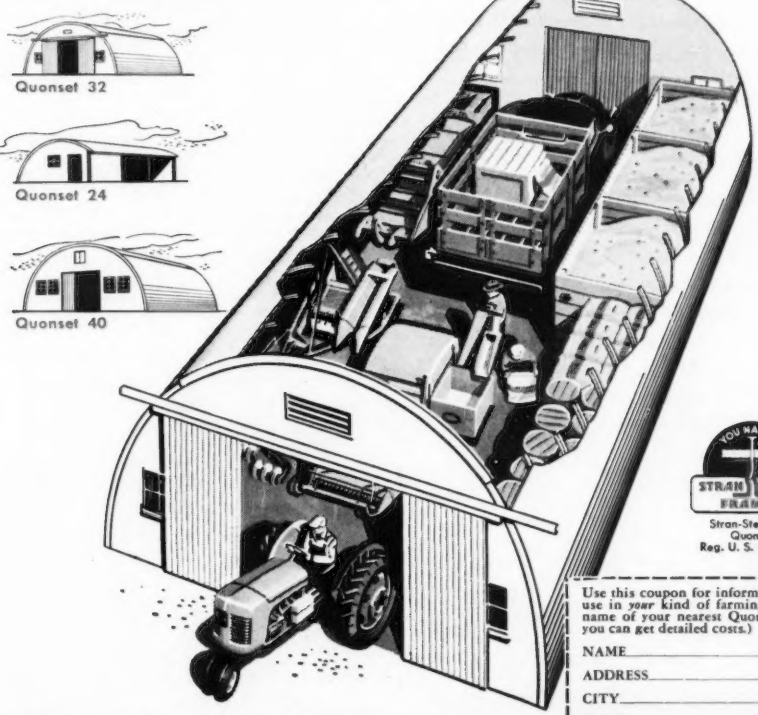
All over America, farmers of all kinds—in every section of the country—are ready to back up statements like this because their *experience* with Quonsets has proved the Quonset's real *value* as a farm building.

Wouldn't you—right now—like to have an all-steel, fire and wind-resistant, vermin-proof building of all-year, all-round usefulness? A building that *works* for you? See your Quonset dealer!

GREAT LAKES STEEL CORPORATION

Stran-Steel Division • Ecorse, Detroit 29, Michigan

PRODUCER OF NI-TEN HIGH TENSILE STEEL



Quonset 32

Quonset 24

Quonset 40

YOU NAIL TO STRAN STEEL FRAMING

Stran-Steel and Quonset Reg. U. S. Pat. Off.

The versatile Quonset is excellent for livestock housing or crop storage. Here a Quonset 32's capacity for all sorts of machinery is shown. Adequate shelter for expensive farm equipment pays for itself in short order!

Use this coupon for information about Quonsets in use in *your* kind of farming. (We will include the name of your nearest Quonset dealer, from whom you can get detailed costs.)

NAME_____

ADDRESS_____

CITY_____

STATE_____

38

NATIONAL STEEL CORPORATION

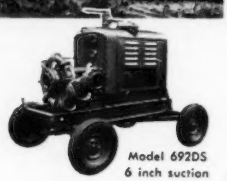
Marlow **WATER WIZARD**

SPRINKLER IRRIGATION PUMPS

. . . dependable

. . . economical

. . . easy to use

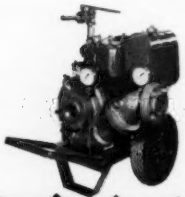


Model 692DS
6 inch suction
and discharge

Modern design — These pumps embody the latest features for modern sprinkler irrigation. Marlow Water Wizards are new . . . designed especially for today's new pressure and capacity requirements. They will supply water dependably. They are thrifty and virtually maintenance-free in operation and are built to last for years.

Complete size range — Marlow centrifugal irrigation pumps offer a wide choice of models for *any* job. Available in 14 models, sizes 2- to 6-inch, including two models designed especially for 2- and 3-acre sprinklers. Capacities 50 to 1900 GPM; pressures 30 to 200 PSI. Gasoline and Diesel engine driven; all models may be equipped for belt drive or supplied direct coupled to electric motors. Skid mounted or with steel wheels or rubber tires.

Model 312S 3 inch
suction and discharge



If the question is Sprinkler irrigation pumps, Marlow is the answer.

Write for full information.

MARLOW PUMPS 255 GREENWOOD AVENUE RIDGEWOOD, NEW JERSEY

Manufacturers of Quality Pumps for Over a Quarter of a Century

NEWS FROM ADVERTISERS

(Continued from page 180)

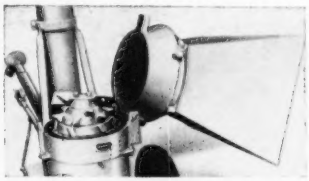
no lubrication. The belt's extreme flexibility permits pulley diameters as small as ½ in at 10,000 rpm, even with a heavy load. Technical information available on request to the Company.

Massey-Harris Self-Propelled Combines. Massey-Harris Co., Racine, Wis., announces changes in design which feature added comfort and greater efficiency on their Super 26 and Super 27 self-propelled combines now in production. M-H combines continue to feature balanced separation as introduced in 1950. A new type upholstered, spring-filled cushion and backrest that takes less space on the platform was incorporated for more operating comfort. A new ladder features high hand rails up to and above the platform, and full depth steps for safety and ease in getting on and off the machine. The design of grain tank unloader auger now permits greater clearance for trucks with high

The new Massey-Harris self-propelled combines—
Super 26 (top) and Super 27 (bottom)

grain boxes. The shaker shoe shaft is mounted on ball bearings and front and rear hangers are mounted on rubber bushings for increased efficiency. Provision has also been made for speeding up the knife, assuring maximum cutting efficiency at high ground speeds. The multiple-speed drive which formerly provided 24 speeds now gives the operator 32 forward speeds from which to choose for proper field travel in all types and conditions of crops. The Super 26 is available with 10 and 12-ft cut and the Super 27 in 12, 14, and 16-ft sizes.

Knoedler Portable Burr Mill. A new portable burr mill operating from the power take-off of any two-plow or larger tractor is now being marketed by Knoedler Manufacturers, Inc., Streator, Ill. It produces a granular grind, is easily moved about the farm, is tractor powered, will discharge into feed bins and is rugged in construction. The new Model KP-7A mill grinds 200 bu of normal moisture ear corn per hour; also grinds shelled corn and corncobs. A special adjusting wheel controls the size of the grind. The burrs are of special alloy



Knoedler portable burr mill

steel, with a cone-shaped design that produces little or no friction heat. They may be changed in less than 5 min. Compact and weighing approximately 500 lb., the mill has a single-unit, auger-type elevator quickly removed for storage or transporting. The swivel discharge spout rotates in a full circle and the shovel-height hopper swings around an arc of about 270 deg. Other features include pressed-steel construction, telescoping power take-off shaft and hauling tongue, safety shear pin in power take-off shaft and easy rolling pneumatic tires.

Circular, Rolled and Welded Steel Products Brochure. The Cleveland Welding Co., W. 117th St. and Berea Road, Cleveland 7, Ohio, has just published a new general catalog of particular interest to original equipment manufacturers who purchase circular, rolled and welded steel products. This catalog illustrates and describes the shapes of rings, bands, hoops, flanges, and weldments *(Continued on page 184)*

NEW!

Soil Conservation Color Film . . .

"Neighbors of the Land"

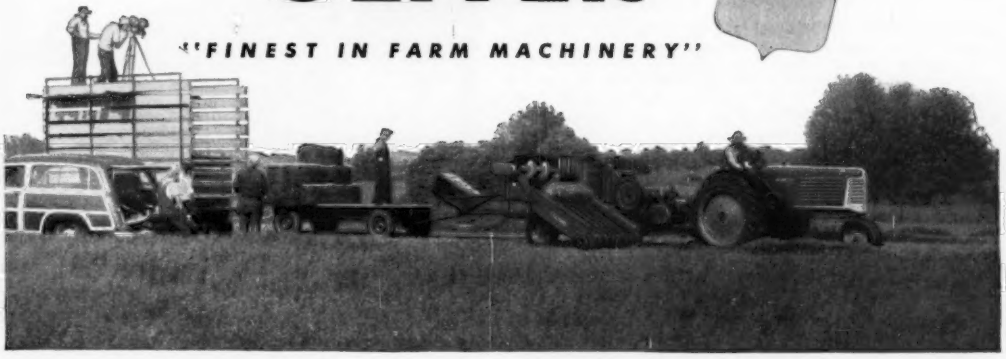
For the first time here's a documentary-type, informational film, dramatizing the creation, development and achievement of a typical *neighbor-group* soil conservation program. "Neighbors of the Land" is devoted expressly to conserving soil and water, and portrays what can be accomplished when neighbors work together.

Oliver films are loaned without charge to agricultural leaders and appropriate groups—county agents, extension workers, vocational agriculture teachers, soil conservationists, farm clubs and civic organizations. Schedule this new full color, 16 mm. sound movie through your neighborhood Oliver dealer or branch office, or write to The OLIVER Corporation, 400 West Madison Street, Chicago 6, Illinois.

OLIVER

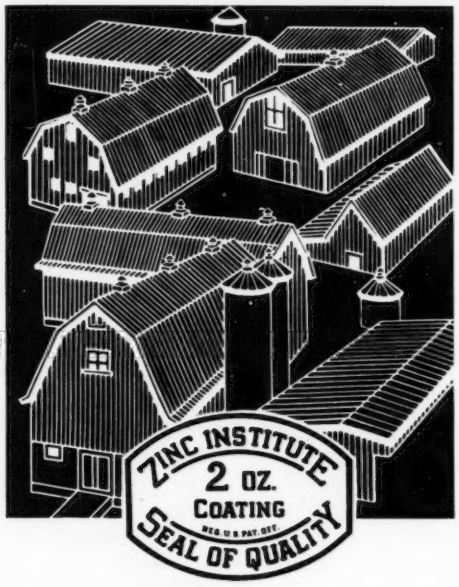
THE OLIVER CORPORATION

"FINEST IN FARM MACHINERY"



On All Your Farm Buildings

GALVANIZED SHEETS GIVE YOU ALL 3!



1. PROTECTION... of valuable crops, livestock and machinery against elements. Galvanized roofing covers more than ⅓ of all U.S. farm buildings today!

2. STAY-ABILITY... Hold at the nail-holes, resist high winds, stay sealed and solid for years and years. *Strength* of steel—*protection* of Zinc!

3. ECONOMY... Reasonable original price . . . low repair and upkeep cost . . . long years of service . . . add up to *economy you can count on* thru the years.

Now, More Than Ever . . . PROPER CARE PAYS! When material shortages threaten to limit new construction and replacement, careful maintenance of present structures is essential. A few simple steps with very little labor can make galvanized roofing a lifetime material. The valuable booklets described below will show you how.

AMERICAN ZINC INSTITUTE
35 E. Wacker Drive, Room 2602
Chicago 1, Illinois

Without cost or obligation, send the illustrated booklets I have checked.

- ☐ Facts About Galvanized Sheets
- ☐ List of Metallic Zinc Paint Mfrs.
- ☐ Directions for Applying Galvanized Sheets
- ☐ Repair Manual on Galvanized Roofing and Siding
- ☐ Use Metallic Zinc Paint to Protect Metal Surfaces

NAME_____

ADDRESS_____

TOWN AND STATE_____

Send for FREE BOOKLETS

NEWS FROM ADVERTISERS

(Continued from page 182)

manufactured by the company. Facilities of the plant are described including equipment and laboratory facilities. In addition, information is given on various metals handled by the company and their specialization in such items as gear blanks, electrical motor shells and frames, truck, tractor and farm implement rims. Free copies of catalog available on request to the company.

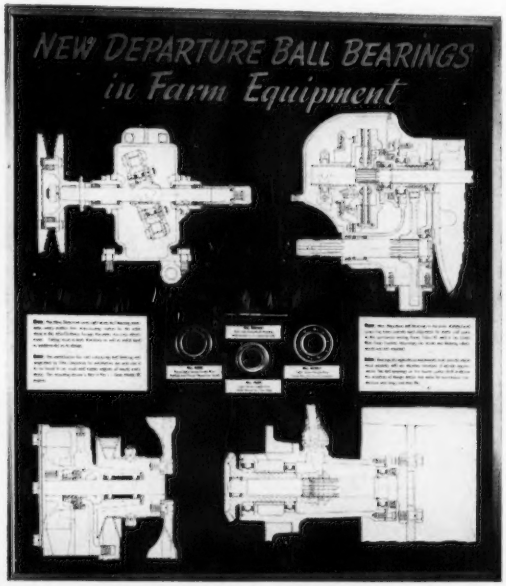
Wisconsin Engine Oil Filter. Wisconsin Motor Corp., Milwaukee, Wis., in collaboration with Wix Accessories Corp., announces the development of a superfilter, especially designed to match the lubrication system of the V-type 4-cylinder Wisconsin air-cooled engines. In line with the movement into a defense economy, where protection and preservation of existing machinery is of utmost importance, this new filter adds many extra hours of dependable service to the life of the engine by keeping the oil free from dirt, filings, and sludge. Called the micro-fine oil filter cartridge, it is a scientific combination of two perfect filtering mediums . . . virgin cotton and plastic impregnated wood cellulose. This filter removes solids of micron size, measuring less than 1/10,000 in. It holds its own dry weight of acids, dirt, and filings, and is competitively priced. The thread of the cartridge is machined to fit perfectly on the oil filter base, assuring a vibrationproof, leakproof oil seal. The manufacturer recommends that the oil filter cartridge should be replaced after each 50 to 100 hr of engine operation, depending on dust conditions, to assure maximum engine protection and most effective utilization of oil.

New Departure Offers Loan of Bearings Display Board

TYPICAL applications of ball bearings in components of farm implements are graphically displayed on a board which is made available on a loan basis by the New Departure Division of General Motors to colleges and universities having courses in agricultural engineering.

Samples of the ball bearings themselves are displayed, as well as the manner of mounting them in various units of farm implements. The transmission mounting, however, where ball bearings are used most generously is not shown because of the wide variety of designs in mountings used by the implement manufacturers.

The board is 36 x 40 inches, and is attractively colored and framed. It is anticipated that this display may be in considerable demand for classroom work and "open houses" as well. The board may be obtained without charge for a limited period by writing to Advertising Department, New Departure, Division of General Motors, Bristol, Conn. It is advisable, however, to make arrangements at least a month in advance of the period required. New Departure offers to pay transportation charges in both directions.



New Departure ball bearings display board

BIGGER YIELDS FROM AVERAGE FIELDS WITH A P.T.O. CLIPPER

The P. T. O. Clipper,* built by Massey-Harris, is a mighty efficient harvesting machine. It takes a full 7-foot cut, gently rubs out grain with its big 5-foot rasp bar cylinder. Separation is complete, bunching is eliminated, and straw is taken in an even flow. It's fast, it's economical, it's profitable to operate because grain loss is held to the minimum.

SKF Self-aligning Ball Bearings hold friction to the minimum, help keep power flowing smoothly, evenly, uninterruptedly.

Builders of all types of agricultural machinery rely on SKF Bearings to heighten the efficiency and customer acceptance of their product. Their policy is sound, and a good one to follow. 7217

*For complete information on the P. T. O. Clipper — or M-H Tractors, Combines and Implements — write The Massey-Harris Company, Racine, Wisconsin.

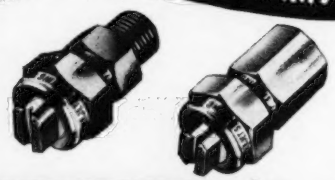
8 REASONS WHY SKF IS PREFERRED BY ALL INDUSTRY

integrity
craftsmanship
metallurgy
tolerance control
surface finish
product uniformity
engineering service
field service

SKF
BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
—*manufacturers of* SKF *and* HESS-BRIGHT *bearings.*

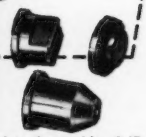
FOR AGRICULTURAL SPRAYING



SPRAYING SYSTEMS

TeeJet

SPRAY NOZZLES



Interchangeable Orifice Tips . . . flat spray, cone spray, and disc-type cone spray. Full range of sizes for every spraying need.

Do you have complete information on Spraying Systems **TeeJet** Spray Nozzles and accessories? **TeeJet** Spray Nozzles are built in every type and capacity for farm spraying. Related Products include strainers, connectors, and valves for better operation of spray booms and portable sprayers. Bulletin 58 gives all details...sent free on request.

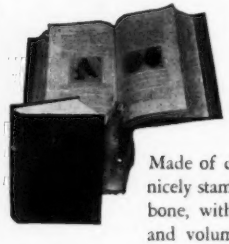
SPRAYING SYSTEMS CO.

Engineers and Manufacturers

3226 RANDOLPH STREET • BELLWOOD, ILLINOIS

WRITE FOR TeeJet BULLETIN 58 HAVE ALL THE FACTS

A Handsome, Permanent Binder *for* AGRICULTURAL ENGINEERING



One copy $2.80

Two or more $2.40 each

The ONLY binder that opens flat as a bound book! Made of durable imitation leather, nicely stamped on front cover and backbone, with name of journal and year and volume number, it will preserve your journals permanently. Each cover holds 12 issues (one volume). Do your own binding at home in a few minutes. Instructions easy to follow. Mail coupon for full information, or binder on 10-day free trial.

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234 West Larned St., Detroit, Mich.

Mail postpaid.....binders for Agricultural Engineering for years.....
W'ill remit in 10 days or return binders collect.

Name.....

Address.....

City.....State.....

Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this bulletin the following listings still current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated:

POSITIONS OPEN: OCTOBER—O-76-508, O-46-509. NOVEMBER — O-102-510. DECEMBER — O-113-514. 1951 — FEBRUARY — O-158-516, 168-517, 173-518, 150-519, 150-520.

POSITIONS WANTED: SEPTEMBER—W-40-10. OCTOBER—W-69-13, 73-14, 71-15. NOVEMBER—W-72-17, 99-18. DECEMBER—W-114-22, 1951—JANUARY—W-106-24, 140-25, 145-27. FEBRUARY—W-148-29, 151-30, 156-31, 152-32, 162-33, 163-34, 164-35.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER (instructor or assistant professor) for research and experimental work on farm machinery and farm structures, with possibly some teaching, at a land grant college in the West. BS or MS deg in agricultural engineering or equivalent. Farm background desirable. Age 23-30. Salary about $3600, depending on qualifications. O-174-521

AGRICULTURAL ENGINEERS (7) for agricultural modernization and development work in North Africa. Work will include management of machines and mechanized crop production, training of operators, research, and advisory service to individual farmers. BS deg in agricultural engineering, or equivalent. Experience in teaching, extension, research or management of mechanized farming desirable. One man familiar with cotton mechanization and one with rice production particularly desired. Single men preferred. Must pass strict physical examination. Men employed will form nucleus of an expanding agricultural engineering service. Three-year contract renewable for two additional years. Liberal leave provisions. Age 27-33. Salary, about $4500 (at present rate of exchange). Interview in the U.S. or Canada prior to April 10. O-186-522

NEW POSITIONS WANTED

EXTENSION, teaching, or research in soil and water field, with college, manufacturer, distributor, consultant, or farming operation, anywhere in the U.S.A. BS deg in agricultural engineering expected in 1951, University of Massachusetts. Pre college training in agricultural school. Farm laborer 3 years. Laborer on bridge construction job, 3 mo. Transitman for city engineering department 3 mo. Cadreman, training recruits, one year. War non commissioned service 15 mo. Married. Age 23. Vision corrected to 20-30. Available Aug. 15. Salary $3000 min. W-116-36

SALES, service, or management in power and machinery field with college, experiment station or manufacturer in U.S.A. or India. BS deg in agricultural engineering, 1950, Allahabad Agricultural Institute. Vacation work 2 mo. as student apprentice with central tractor organization with commercial distributor of tractors in India since graduation as assistant agricultural engineer. Single. Age 19. No disability. Available on reasonable notice. Salary $200 mo in U.S.A., Rs 350 in India. W-120-37

DESIGN, development, or research in supervisory capacity, with manufacturer of dairy equipment or general farm equipment, preferably in Southwest. Also management of farm equipment service and supply companies. Education in industrial arts and engineering, Central Michigan College of Education. Graduate study by extension and summer courses, and by night classes at University of Notre Dame, in industrial and mechanical engineering. Additional training in business administration. Farm background. Experience teaching engineering subjects in high schools in Michigan 15 years. Estimator and field engineer on building construction, 2 years. Plant manager and design engineer on farm equipment, 3 years. Additional experience in sales engineering. Present position as chief engineer in charge of research, design, and development of dairy and farm equipment, past 5 years. Interested in opportunity for professional progress. Married. Age 50. No disability. Available on 30 days' notice. Salary $6000-$7000. W-171-38

(Continued on page 188)

PROFESSIONAL DIRECTORY

FRANK J. ZINK ASSOCIATES

Agricultural Engineers

Frank J. Zink Earl D. Anderson

Wendell C. Dean

Development - Design - Research - Markets - Public Relations

BOARD OF TRADE BLDG., CHICAGO 4, ILLINOIS • • Tel. HArrison 7-0722

RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

"... $26,500,000 worth of U.S. Savings Bonds a year under company Payroll Savings Plan..."

CHARLES E. WILSON

"General Electric employees are buying more than $26,500,000 worth of U. S. Savings Bonds a year under company payroll savings plans. Since the inception of our savings plans in 1917, General Electric employees have saved $445,000,000 of which $280,000,000 consisted of the purchase of United States Savings Bonds since May, 1941. The record speaks for itself."

The record of General Electric Company, and the records of more than 21,000 other large companies, prove that employees *want* to save the easy, automatic way—the Payroll Savings Plan.

As of November 1, 1950, more than 8,000,000 employees were buying U. S. Savings Bonds *every month*. While the figure was impressive, it was not as large as it should have been—a fact recognized by many companies.

In November and December, top executives of literally thousands of large companies (employing one hundred or more) decided to check their Payroll Savings Plan and endeavor to increase participation to 60% or more.

Here are a few December reports: in one of the larger units of a leading steel corporation, participation went from 20% to 80.6 per cent . . . a well-known independent steel company (13,710 employees) reported 82% participation . . . another large steel company (100,000 employees), 75% participation . . . one plant of a large rubber corporation climbed to 94% (company average, all plants, 70%—and still going up). Tabulation of all companies exceeding 60% participation in December would literally fill this page.

Higher participation in the Payroll Savings Plan is good for the men and women for whom it builds security. It is good for the company because a saving employee is a better workman, a better citizen. It is good for the country because the month after month purchase of U. S. Savings Bonds by millions of Americans is a most effective check on inflationary tendencies.

Phone, write or wire, now, to Savings Bond Division, U. S. Treasury Department, Suite 700, Washington Building, Washington, D.C. Your State Director has a simple, four-point promotion plan, concluding with a person to person canvass that puts a Payroll Savings Application Blank in the hands of every employee. That's all you have to do—and you'll be surprised at the response from employees who *want* to save.

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AGRICULTURAL ENGINEERING

PERSONNEL SERVICE BULLETIN

(Continued from page 186)

DESIGN, development, research, sales, or service in power and machinery or farm structures, in public service or industry, anywhere in the U.S. BS deg in agricultural engineering, 1943, University of Georgia. MS deg in agricultural engineering, 1947, Iowa State College. Research in rural housing and farm buildings 3 years, in a college in the Midwest. Enlisted and commissioned war service in Army, 32 mo., including 2 years as tank maintenance officer. Present employment in laundry plant supervision, maintenance, and purchasing. Married. Age 28. No disability. Available April 1. Salary open. W-172-39

DESIGN, development, or research in power and machinery or rural electric field with manufacturer or processor in Connecticut. Training in agriculture and in mechanical engineering to be completed in June, University of Connecticut. Experience in farm work and milk delivery, four summers. Soil conservation aid, one summer. Service mechanic for farm equipment dealer, one summer. War non commissioned service in Army Antiaircraft Artillery, 34 mo. Single. Age 27. No disability. Available in July. Salary $3000. W-184-40

DESIGN, development, research, or writing, in rural electric or power and machinery field with industry or public service in U.S.A., Hawaii or South America. BS deg in agricultural engineering, 1949, University of Georgia. Farm background. War service in Navy as aviation mechanic, 3½ years. Power use adviser with an REA Co-op during past year. Single. Age 26. No disability. Available now. Salary $3000. W-176-41

DEVELOPMENT, research, or management in the soil and water field, preferably in a farming operation in the Southeast. BS deg in agricultural engineering 1949, North Carolina State College. MS deg in agricultural engineering expected in June, Virginia Polytechnic Institute. Farm background. Full time instructor since fall 1950, in soil and water conservation and farm machinery in a college in the Southeast. War enlisted service in Infantry intelligence, 3 years. Married. Age 29. No disability. Available in July. Salary open. W-185-42

SALES, service, or writing in power and machinery or soil and water field, with manufacturer, distributor or trade association, preferably in Northeast. BS deg in agricultural engineering expected June 17, University of Maine. Considerable farm experience. Carman doing general repair work on railway passenger and freight cars, 2 years. Carpenter at University of Maine and in private home construction during summer vacations. War enlisted service in Navy, 3 years. Married. Age 28. No disability. Available June 18. Salary open. W-188-43

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TUTHILL Model 5W and 5WCN Pump Series Tops the Field in Weed and Pest Control Service

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These compact, dependable units handle insecticides, herbicides and fungicides commonly used for this service. Model 5W is made of corrosion-resisting materials for water base solutions. Model 5WCN is of all iron construction with exclusive new needle bearings—for oil base solutions.

Both pumps are designed for direct mounting on power take-off. Over-all dimensions: 4½" x 5½" x 6⅜". Pressure range from 0 to 150 p.s.i. Delivers 5 g.p.m. at 100 p.s.i. at 550 r.p.m.; 16 g.p.m. at 100 p.s.i. at 1750 r.p.m. Self-priming...self-lubricating.

Write or wire for complete information.

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939 East 95th Street, Chicago 19, Illinois

NEW BULLETINS

Effect of Combine Adjustment on Harvest Losses of Rice, by Xzin McNeal, Arkansas Agricultural Experiment Station (Fayetteville) Bulletin 500 (December, 1950). Reports on field tests of five makes of self-propelled combines. Shatter, cylinder, cutter bar, rack, and shoe losses are separately summarized. Operator performance is indicated to be a larger factor than machine differences in influencing amount of loss. Low ground speed under adverse conditions, attention to cutting height or length of straw, and condition of cylinder bars and concaves are mentioned as important in holding losses to a minimum.

When to Harvest Rice for Best Milling Quality and Germination, by Xzin McNeal, Arkansas Agricultural Experiment Station (Fayetteville) Bulletin 504 (December, 1950). Reports on test harvestings at moisture contents from 30 to 13 per cent showed best results from harvesting various varieties between upper moisture limits of 22, 23, and 24 per cent and lower moisture limits of 16 or 17 per cent.

Entombed Knowledge

(Continued from page 141)

about by chariot as a travelling library? Were copies of it made available at every oasis? It is not hard to believe that the existence of only one original in a tomb and carefully guarded by scribes may have discouraged reference almost as effectively as some modern conditions.

Did the people of Sumeria or their leaders one day lose sight of the importance of agricultural productivity? Were they careful to preserve the productivity of their land, and to protect their water supply? Did they encourage the improvement of their farm equipment? Did they use either too much or too little of their productive strength as a bulwark against internal and external enemies seeking unearned shares in their production? Did they dissipate their productive strength in aggression against neighboring peoples or in communistic concentration on sharing the wealth of grain already harvested?

So far as Sumeria is concerned, these questions are academic. But apply them to any nation or civilization today and they raise vital questions of policy.

If we read correctly this 3700-year old agricultural extension bulletin, it says that no civilization, nor its supporting production capacity, nor the use of that production, can safely be taken for granted. Man's attitude toward production, distribution, and use of material things is a strong influence on his destiny.

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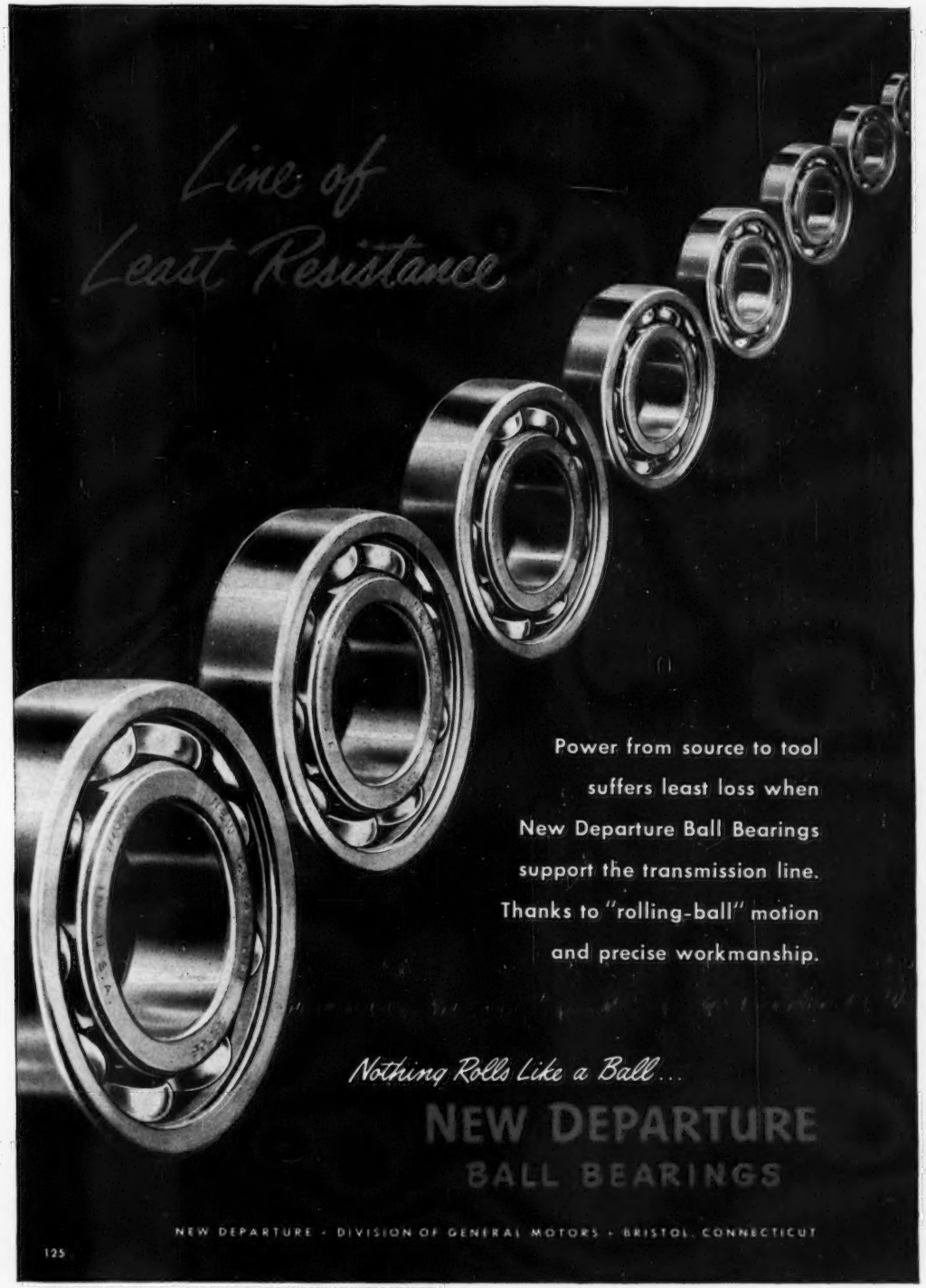
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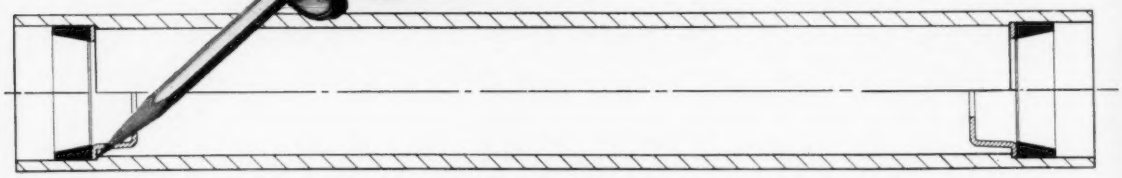

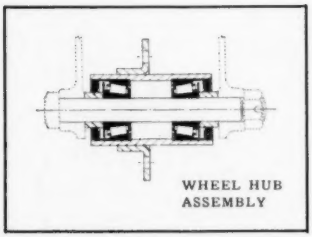

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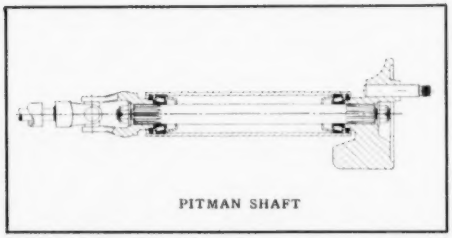

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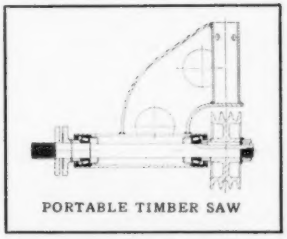

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As shown in the top illustration, the Timken bearing cup seats are machined to a shoulder. Tubes are supplied with or without the cups pressed in place. Inner closures and rings for alternate cup backing designs are indicated above and below the center line. Tubes are furnished with 2¼", 2¾" and 3" O.D. and in lengths of 2½ inches to 120 inches with closures available to fit the tube selected.

Some of the proven applications of this new Timken bored seat tubing now in production are shown in the three line drawings.

Additional technical data on Timken bored seat tubing is in the General Information Section, Timken Engineering Journal, pages 1-260 to 1-264. For your free copy, drop a card or letter to: The Timken Roller Bearing Company, AE Sales Promotion Manager, Canton 6, Ohio. Cable address "TIMROSCO".

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